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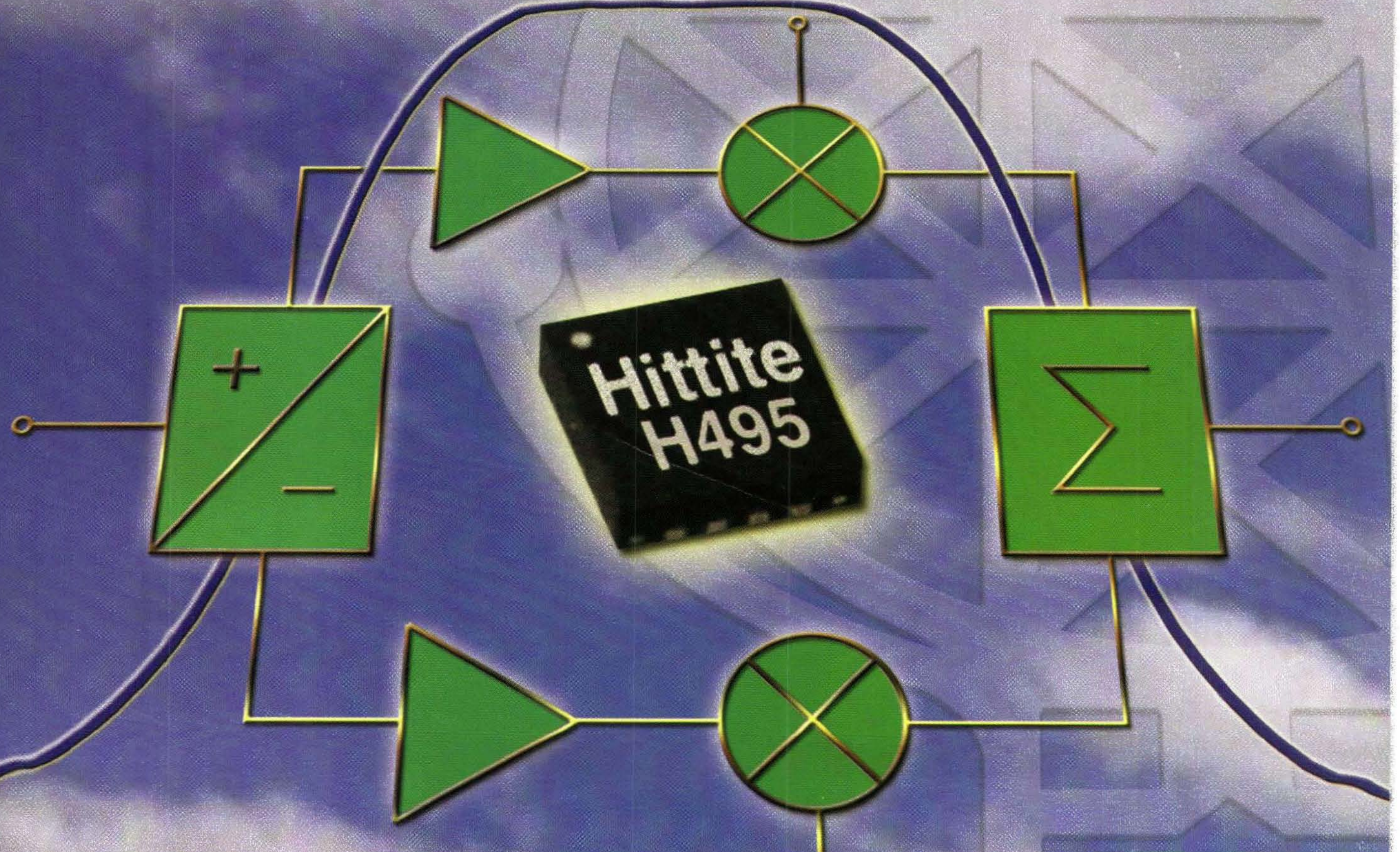
Microwaves & RF

News
Surveying advanced frequency synthesizers

Design Feature
Smart synthesizers simplify RF integration

Product Technology
C/N generators cover 0.8 to 6.0 GHz

SiGe Direct Modulators Span Wide Dynamic Range



Frequency Synthesis Issue

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AGC & AFC SUBSYSTEMS AND SUPERCOMPONENTS

HIGH PERFORMANCE LOW INTERMODULATION AGC AMPLIFIERS

MODEL NUMBER	CENTER FREQUENCY (MHz)	FREQUENCY SPAN (MHz)	DYNAMIC RANGE (dB)	GAIN FLATNESS (±dB)	AGC GAIN VARIATION (dB)
HAGC-70-21-.4-15-I/O*	21.4	15	70	0.15	0.5
HAGC-70-30-20-I/O*	30	20	70	0.25	0.5
HAGC-70-70-40-I/O*	70	40	70	0.30	0.5
HAGC-70-140-80-I/O*	140	80	70	0.60	0.6
HAGC-60-160-80-I/O*	160	80	60	0.60	0.6

*Input(I)/output(O) impedance can be 50 (I or O = 5) or 75 (I or O = 7) ohms independent of each other

- Low Power Consumption
- Models Are Available With Various Dynamic Ranges
- Very Low Intermodulation Distortion (65 dB typical across dynamic range)

HIGH PERFORMANCE PULSED IF ANALOG AGC AMPLIFIERS

MODEL NUMBER	CENTER FREQUENCY (MHz)	FREQUENCY SPAN (MHz)	DYNAMIC RANGE (dB)	AGC RESPONSE TIME (Pulse Bursts)	AGC TRACKING ACCURANCE* Δ PIN ≤ 65 dB: 250 ns PULSE (dB Max.)	500 ns PULSE (dB Max.)	2µs PULSE (dB Max.)
GAGC-65-21.4-6	21.4	6	65	25	<± 2.5	<± 2	<± 2
GAGC-65-30-10	30	10	65	25	<± 2.5	<± 2	<± 2
GAGC-65-70-24	70	24	65	25	<± 2.5	<± 2	<± 2
GAGC-65-140-40	140	40	65	25	<± 2.5	<± 2	<± 2
GAGC-65-160-60	160	60	65	25	<± 2.5	<± 2	<± 2

*Settled response over multiple pulse bursts. Minimum operating pulse width (PW) is 250 ns. Minimum PRF is 160 Hz.

- Digital/Analog Processing Feedback Circuitry

HIGH PERFORMANCE PULSED IF ANALOG AFC AMPLIFIERS

MODEL NUMBER	CENTER FREQUENCY (MHz)	PEAK-TO-PEAK BANDWIDTH (MHz)	TRANSFER SLOPE (V/MHz)	PULSE WIDTH (µs)	DROOP RATE µV/MS
AFCP-5-21.4-6	21.4	6	0.8	0.5	75
AFCP-8-30-10	30	10	0.5	0.4	75
AFCP-16-60-20	60	20	0.25	0.2	60
AFCP-20-70-24	70	24	0.20	0.18	60
AFCP-28-140-40	140	40	0.15	0.125	60
AFCP-30-160-60	160	60	0.125	0.100	60

- Stable Detected Output With Low Offset

HIGH PERFORMANCE DIGITALLY-LOCKED PULSED AFC SUBSYSTEMS

MODEL NUMBER	CENTER FREQUENCY (MHz Nom.)	AFC CAPTURE RANGE (±MHz)	DIGITAL CAPTURE RANGE (±MHz)	ACCUMULATED ACCURACY*: 250 ns PULSE (kHz, Max.)	500 ns PULSE (kHz, Max.)	1µs PULSE (kHz, Max.)	10µs PULSE (kHz, Max.)
DAFC-21/6	21.4	3	1.5	350	150	100	15
DAFC-30/10	30	5	2	250	125	75	10
DAFC-35/14	35	7	2.5	250	125	75	10
DAFC-60/20	60	10	4	200	100	75	10
DAFC-160/40	160	20	10	175	100	75	10

*Settled response over multiple pulse bursts. Minimum operating pulse width (PW) is 250 ns. Minimum PRF is 160 Hz.

- Remote Capability
- Very Fast Capture With Integrated VCO (Optional)
- Ultra-Accurate Stability With Digital/Analog Capture Range Processing

For additional information, contact
Jack Hakoopian at (631) 439-9130 or jhakoopian@miteq.com

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Broadband Power Amplifiers NEW

Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ
JCA018-3000	2.0–18.0	25	6.0	2.0	23	28
JCA218-3001	2.0–18.0	25	6.0	2.0	25	30
JCA218-3002	2.0–18.0	25	6.0	2.0	27	32
JCA218-4000	2.0–18.0	30	6.0	2.0	23	28
JCA218-4001	2.0–18.0	30	6.0	2.0	25	30
JCA218-4002	2.0–18.0	30	6.0	2.0	27	32
JCA218-5000	2.0–18.0	35	6.0	2.0	23	28
JCA218-5001	2.0–18.0	35	6.0	2.0	25	30
JCA218-5002	2.0–18.0	35	6.0	2.0	27	32

Power Amplifiers

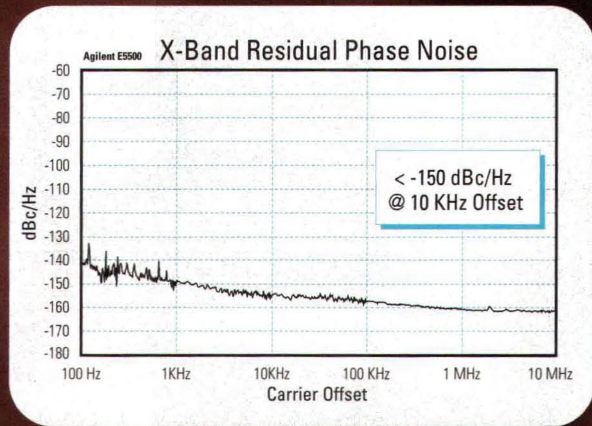
Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ
JCA12-P01	1.35–1.85	35	4.0	1.0	33	41
JCA34-P02	3.1–3.5	40	4.5	1.0	37	45
JCA56-P01	5.9–6.4	30	5.0	1.0	34	42
JCA812-P03	8.0–12.0	40	5.0	1.5	33	40
JCA1218-P02	12.0–18.0	22	4.0	2.0	25	35

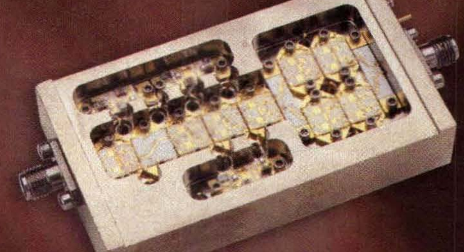
Low Noise Amplifiers

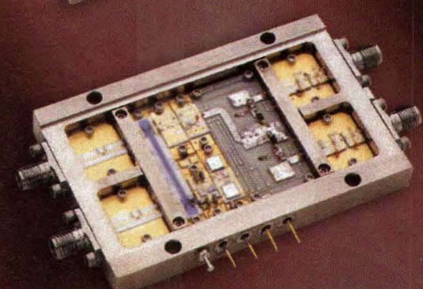
Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ
JCA12-1000	1.2–1.6	25	0.8	0.5	10	20
JCA12-3001	1.0–2.0	40	0.8	1.0	10	20
JCA23-302	2.2–2.3	30	0.8	0.5	10	20
JCA34-301	3.7–4.2	30	1.0	0.5	10	20
JCA78-300	7.25–7.75	27	1.2	0.5	13	23
JCA910-3000	9.0–9.5	25	1.3	0.5	13	23
JCA1112-3000	11.7–12.2	27	1.4	0.5	13	23
JCA1415-3001	14.4–15.4	35	1.6	1.0	14	24
JCA1819-3001	18.1–18.6	25	2.0	0.5	10	20
JCA2021-3001	20.2–21.2	25	2.5	0.5	10	20

Millimeter Wave Amplifiers

Model	Freq. Range GHz	Gain dB min	N/F dB max	Flatness +/-dB	1 dB Comp. pt. dBm min	3rd Order ICP typ
JCA2629-201	26.0–29.0	19	5.0	1.5	5	15
JCA2629-401	26.0–29.0	35	5.0	1.5	5	15
JCA2730-205	27.5–30.0	15	5.0	1.0	15	25
JCA2730-302	27.5–30.0	26	5.0	1.0	8	18
JCA2730-502	27.5–30.0	43	5.0	1.0	8	18
JCA3031-102	30.0–31.0	18	5.0	1.5	8	18
JCA3031-302	30.0–31.0	34	5.0	1.5	8	18
JCA3031-405	30.0–31.0	40	5.0	1.5	15	25
JCA2640-301	26.5–40.0	30	5.0	2.5	0	10







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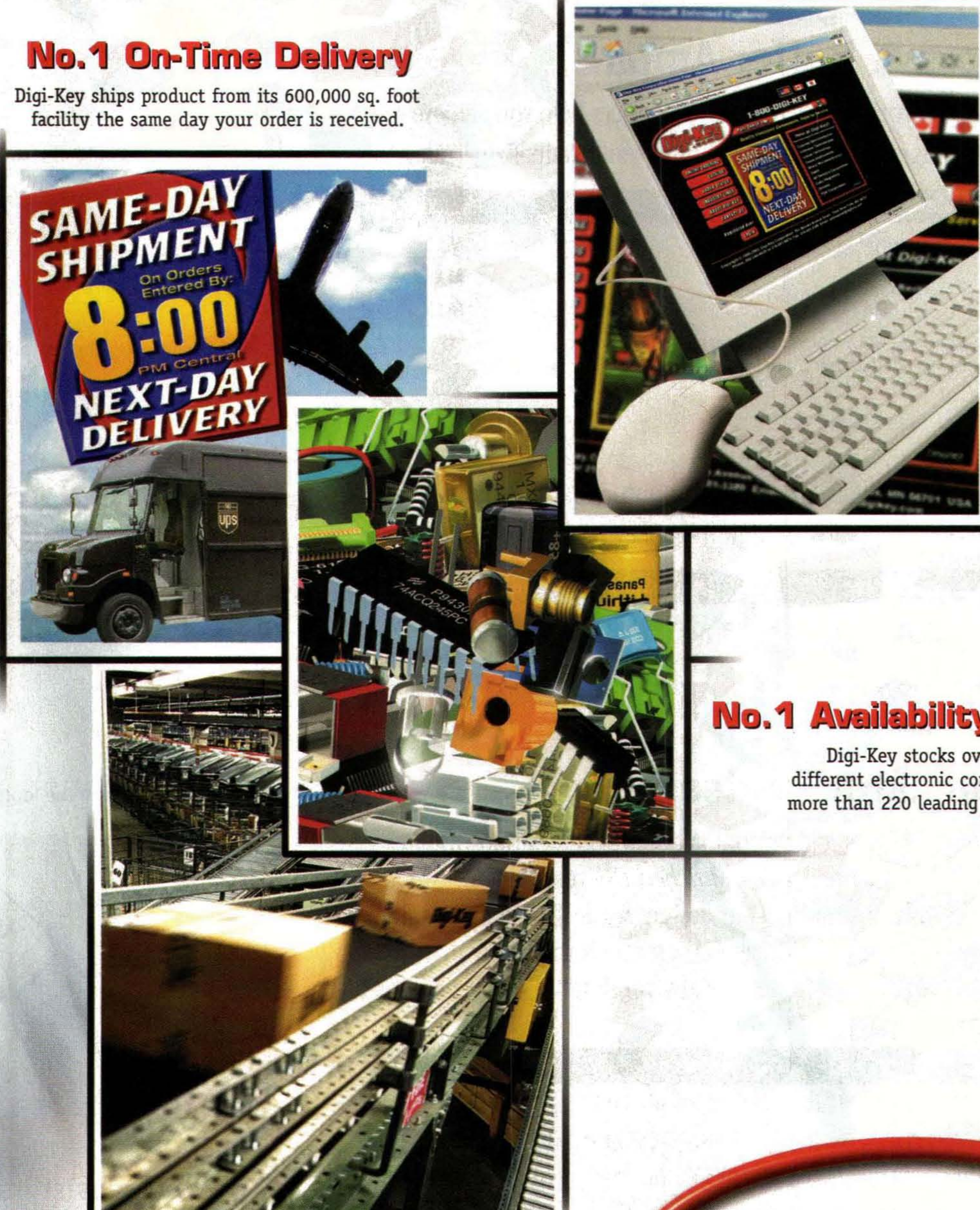

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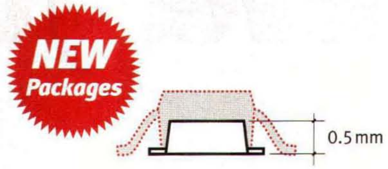


- **Flat Lead** design reduces parasitics and improves electrical performance
- **Low Profile** is ideal for VCO modules and other space-constrained designs

Oscillators & Buffer Amps

With the best *1/f* performance available, these devices help you achieve the phase noise your design demands. They're also available in Twin Transistors.

Part Number	Corner Freq*	V_{CE}	I_C	Package
NE851M13	1 KHz	1 V	5 mA	**M13**
NE894M13	3 KHz	1 V	5 mA	**M13**
NE685M13	5 KHz	3 V	5 mA	**M13**

**Review Application Note AN1026 on our website for more information on 1/f noise characteristics and corner frequency calculation.*

M13 One sixth the footprint a SOT-323

LNAs

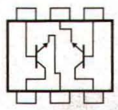
Need low noise and high gain in an ultraminiature package for your hand-held wireless products? These new high frequency NPN transistors deliver!

Part Number	Description	NF	Gain	Freq	Package
NESG2021M05	35 GHz f_T LNA	1.3 dB	11 dB	5.2 GHz	**M05**
NE662M04	23 GHz f_T LNA	1.1 dB	16 dB	2 GHz	**M04**
NE687M13	14 GHz f_T LNA	1.4 dB	14 dB	1 GHz	**M13**

M04/M05 Half the footprint of a SOT-143

Twin Transistor Devices

Cascode LNAs, cascade LNAs and oscillator/buffer combinations are just three possible uses of these versatile devices. *Matched Die* versions pair two adjacent die from the wafer to help simplify your design, while *Mixed Die* versions — an NEC exclusive — let you optimize oscillator performance while achieving the buffer amp output power you need. Many combinations are available.



One of three pin-outs available

Part Number	Description	Q1 Spec	Q2 Spec
UPA802TC	Matched Die/Cascade LNA	NE681	NE681
UPA895TD	Matched Die/Dual Oscillator	NE851	NE851
UPA861TD	Mixed Die/Osc-Buffer Amp	NE687	NE894
UPA862TD	Mixed Die/Osc-Buffer Amp	NE685	NE851

TD Twin Transistors

Less than one third the footprint of a SOT-363.

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Microwaves & RF

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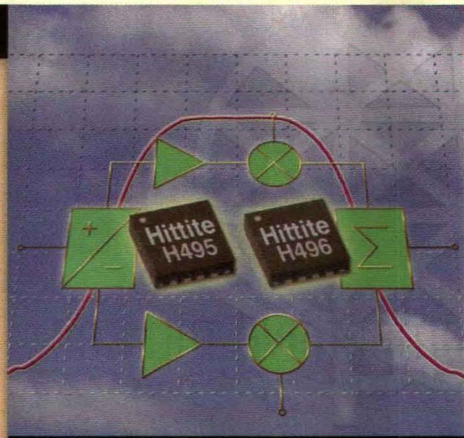

COVER STORY

News

Design

Product Technology

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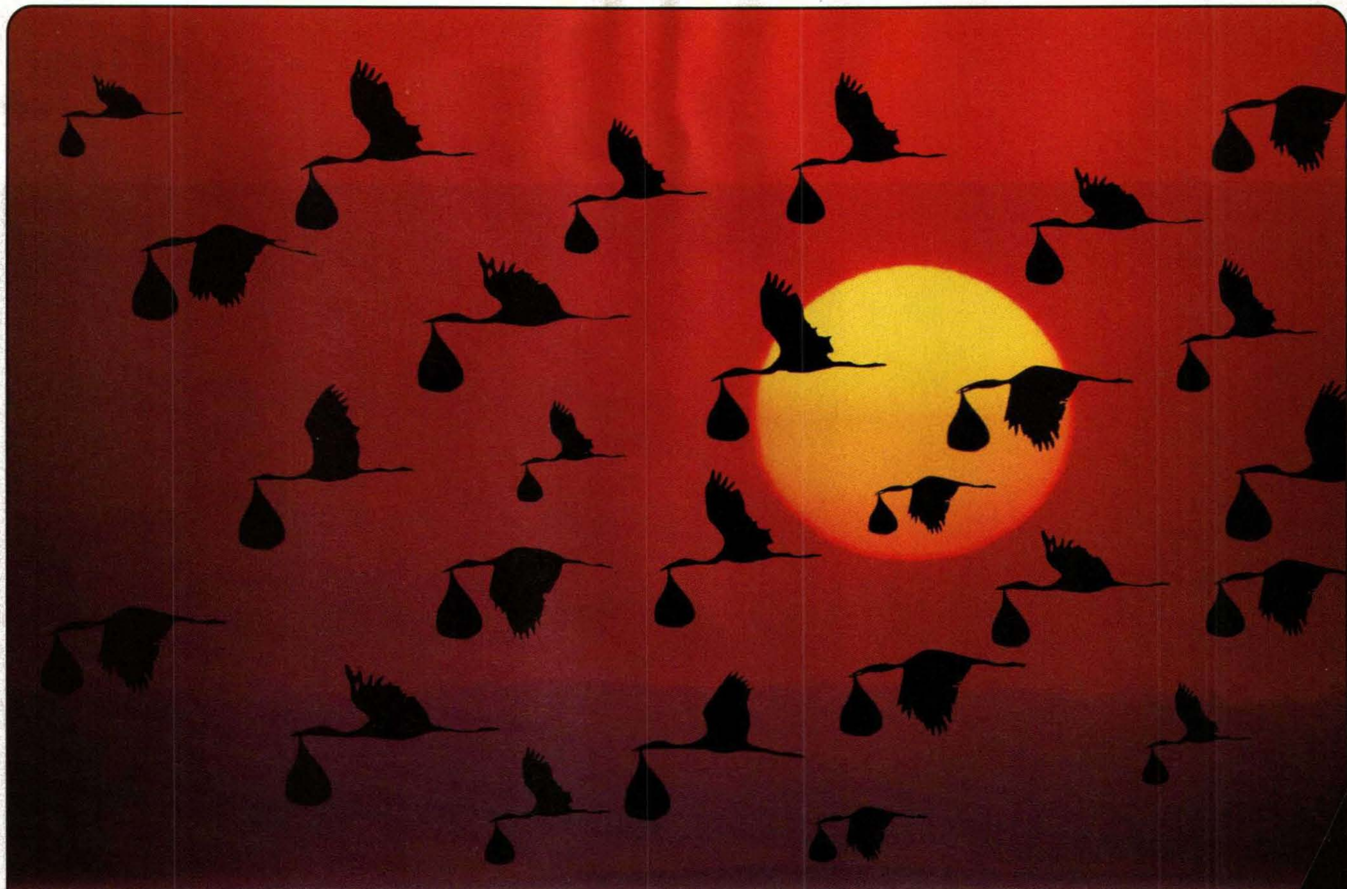

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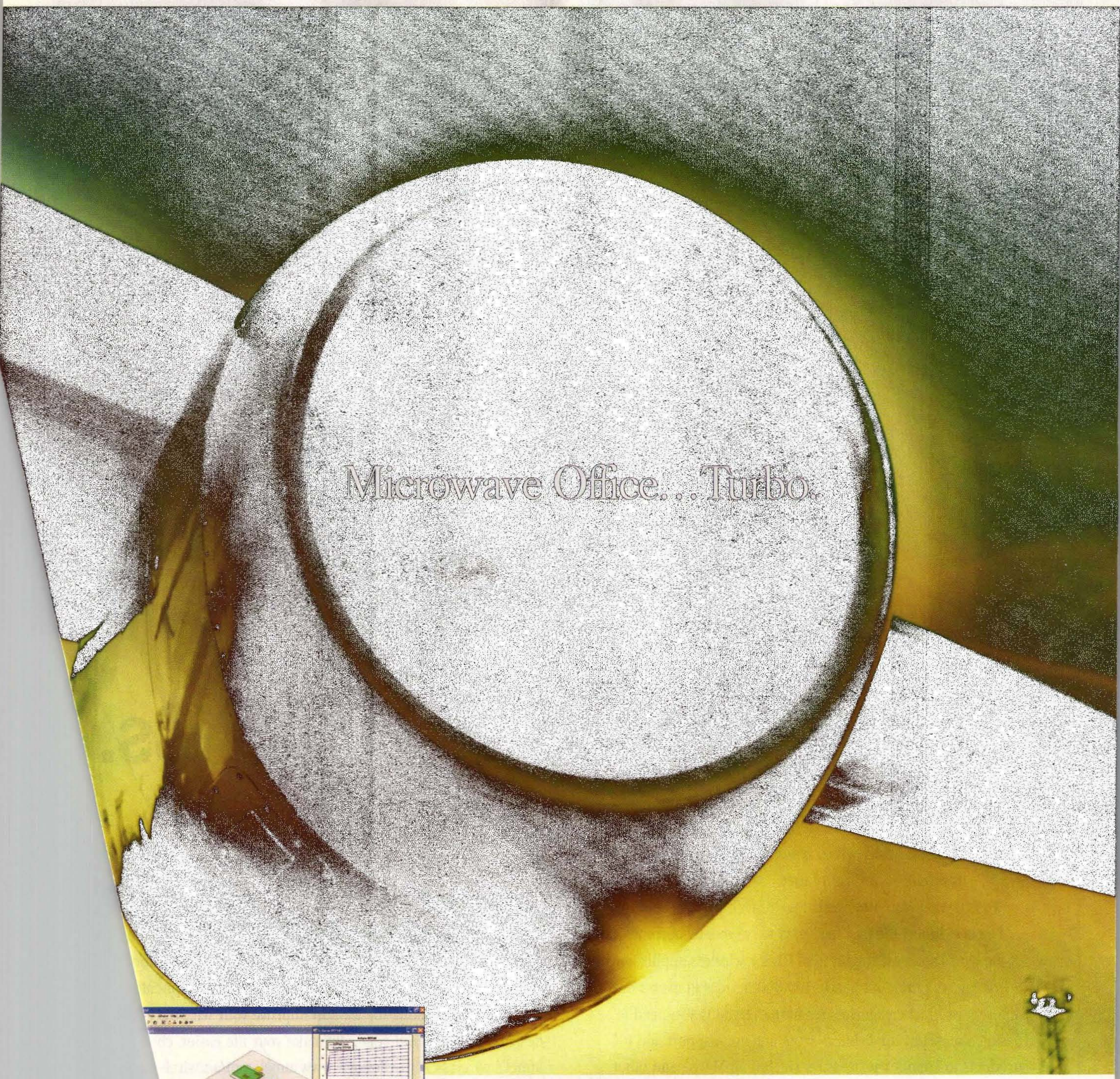
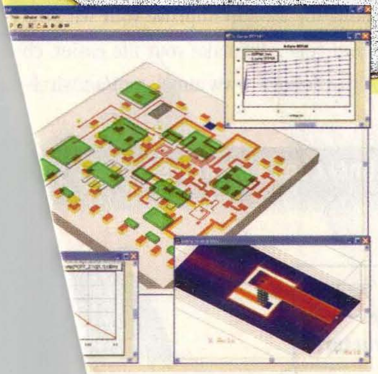
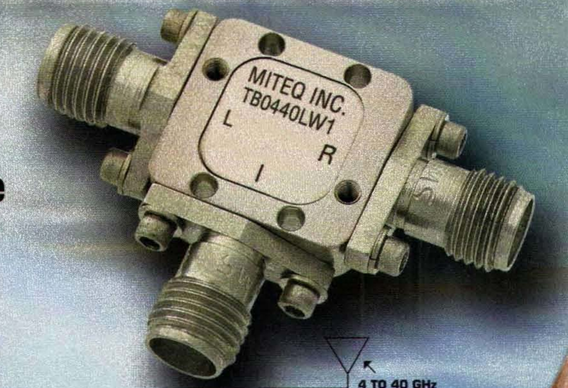


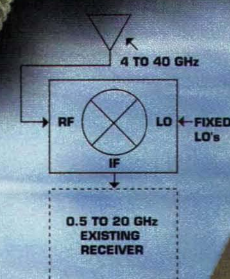


4 – 40 GHz

BLOCK DOWNCONVERTER

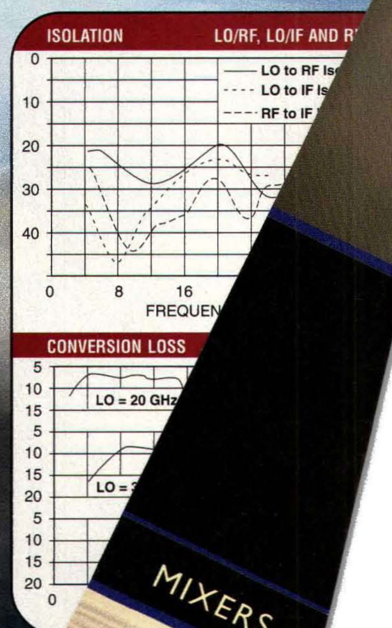


MITEQ's Model TB0440LW1 allows the use of existing wide bandwidth receivers over millimeter frequency bands!



FEATURES:

- RF/LO Coverage..... 4 to 40/4 to 42 GHz
- IF Operation............ 0.5 to 20 GHz
- LO Power Range .... +10 to +15 dBm (usable at +7 dBm)
- RF to IF Isolation.... 25 dB
- Removable K Connectors
- From Stock



INPUT PARAMETERS	MIN.	TYP.	MAX.
RF frequency range (GHz)	4		40
RF VSWR (RF = -10 dBm, LO = +13 dBm)		2.5:1	
LO frequency range (GHz)	4		42
LO power range (dBm)	+10	+13	+15
LO VSWR (RF = -10 dBm, LO = +13 dBm)		2.0:1	
TRANSFER CHARACTERISTICS	**MIN.**	**TYP.**	**MAX.**
Conversion loss (dB)		10	12
Single sideband noise figure (dB, at +25° C)		10.5	
Isolation - LO to RF (dB)	18	20	
Isolation - LO to IF (dB)	20	25	
Isolation - RF to IF (dB)	20	30	
Input power at 1 dB compression (dBm)		+5	
Input two-tone 3rd order intercept point (dBm)		+15	
OUTPUT PARAMETERS	**MIN.**	**TYP.**	**MAX.**
IF frequency range (GHz)	0.5		20
IF VSWR (RF = -10 dBm, LO = +13 dBm)		2.5:1	

For additional information, please contact Mary Bec
or e-mail mbecker@miteq.co

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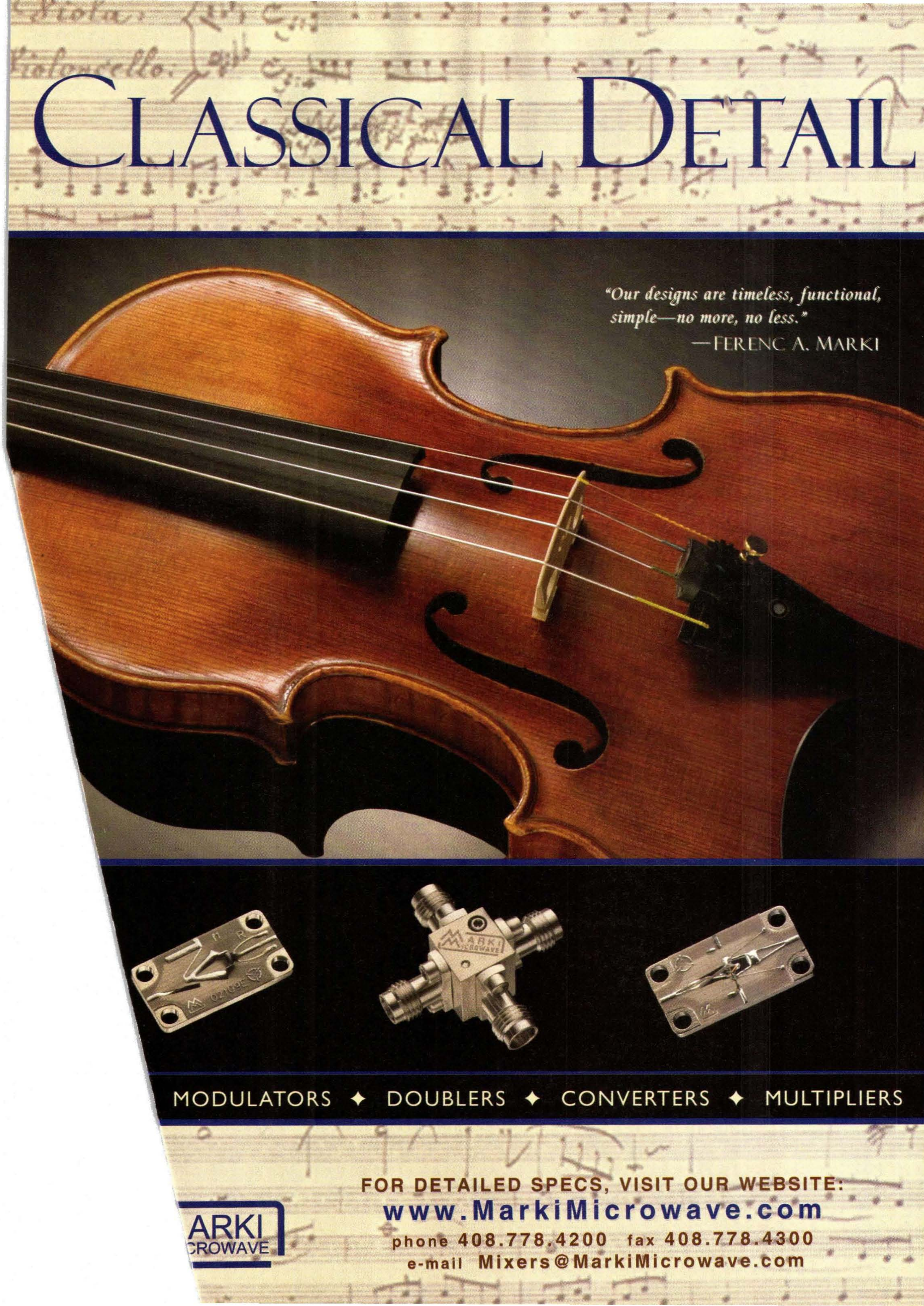
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Contents Correction

▶▶IN THE TABLE OF CONTENTS of *Microwaves & RF's* September 2003 issue, the Product Technology article on p. 108 was listed as "Testers Mimic Propagation Losses To 13.25 GHz." That article ran in the August 2003 issue and was repeated in the September 2003 table of contents due to an editorial error. The correct title of the article on p. 108 should have been "Low-Cost Transceiver Drives Wireless USB." We apologize to the readers for any confusion that this error may have caused.

The Editors of Microwaves & RF

MES 2003

▶▶BARRY INDUSTRIES attended the recent MES show at the Baltimore Convention Center in Baltimore, MD with the expectation that its location and target audience would pay dividends as far as generating leads and interest in our company. We were exhibiting our state-of-the-industry Low Temperature Cofired Circuit (LTCC) capability. This LTCC capability enables a full front end microwave system to be assembled on a multilayer circuit in a fraction of the space of a soft substrate solution. LTCC allows for the configuration of passive and active components in the same circuit.

We were targeting Prime Contractors in the aerospace and defense industry, and we had great contact with end users from Army and Navy research establishments as well as the likes of BAE Northrop Grumman, Raytheon, and Thales. We will definitely be exhibiting in the future.

Barry Industries is an ISO 9001:2000 approved company. If you are interested in learning more about Barry Industries, please visit our website at www.barryind.com.

Rob Sinclair
Barry Industries

Editor's Note: Rob, thanks very much for your comments about MES 2003. We appreciate all who exhibited at the show as well as those who attended. We hope to see everybody at next year's shows in San Diego and Baltimore.

PLEASE COMMENT

Microwaves & RF welcomes mail from its readers. Letters must include the writer's name and address. The magazine reserves the right to edit letters appearing in "Feedback." Address letters to:

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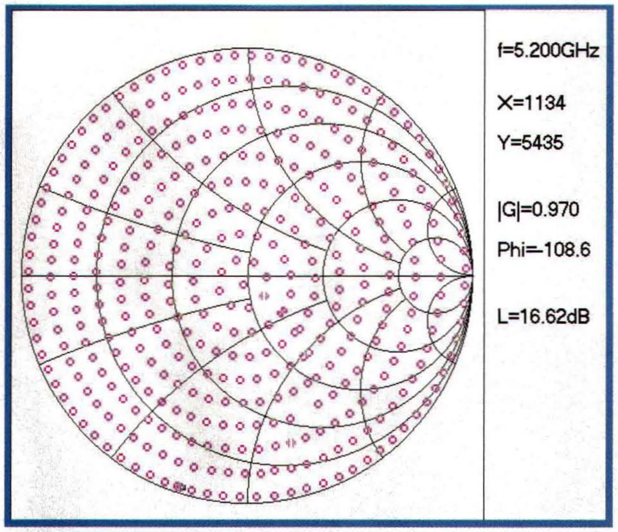
Frequency Selective Tuner

Amplitude and Phase Harmonic Tuning

Focus Microwaves introduces a novel harmonic Load Pull instrument:

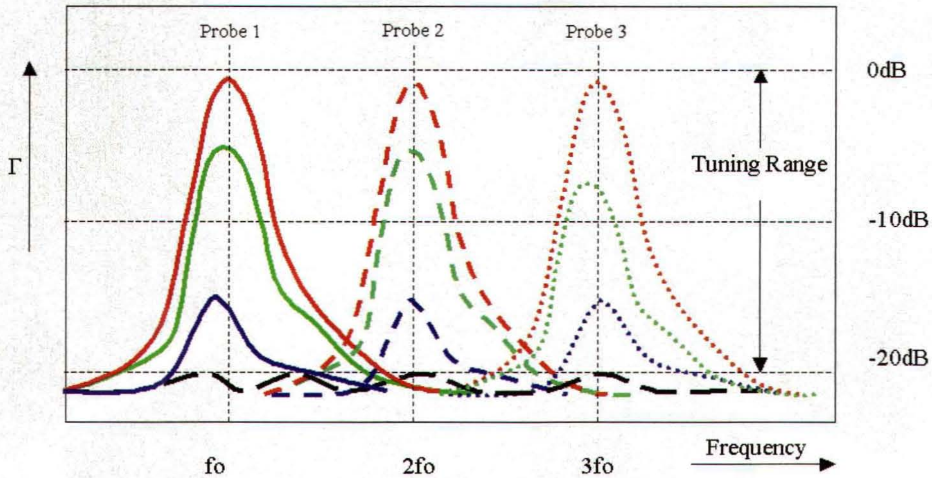
Frequency Selective Tuner FST

The FST* allows to independently adjust impedances at three different frequencies (harmonics). Both amplitude and phase are controllable.



Fo, 2Fo, 3Fo Independently tunable in Γ and ϕ

INDEPENDENT TUNING using resonant probes



* Patent pending

Main Features

- Dynamic range : 20dB/360^{o} at all three frequencies
- Contactless resonant probes
- No lossy Triplexers required
- High power capability
- Highest Γ at Fo
- Compact design with built-in micro-controller
- TCP/IP interface (*i*Tuner)
- On-wafer operation

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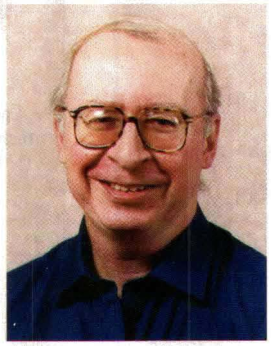
DDS Gains Wider Application



FREQUENCY SYNTHESIZERS HAVE IMPROVED dramatically in recent years. Ten years ago, direct digital synthesis (DDS) was in its infancy; now it is widespread as a primary or secondary technology in many signal sources. Over that time, designers have learned more than a few ways to curb the spurious levels that once plagued the technology. Current DDS designs can routinely achieve spurious levels as good as –60 and –70 dBc without sacrificing the frequency agility that makes DDS technology so attractive.

Frequency agility makes DDS technology attractive to both commercial and military systems integrators.

The technology was often considered frivolous by "serious" synthesizer designs, since the bit resolution of early digital-to-analog converters (DACs) essentially dictated the spurious performance of the end product. A decade earlier, 8-b DACs were the standard at higher clock speeds, essentially limiting high-speed DDS sources to a spurious floor of about 6 dB per bit, or about –48 dBc. Compare that to what is being done with modern DDS designs. As a recent example (see *Microwaves & RF*, April 2003, p. 94), the ADV-3000S DDS from Advanced Radio Corp. (Reston, VA) tunes from 20 MHz to 3 GHz with 1-Hz resolution. Although somewhat slower than some DDS sources, with better than 5-µs frequency switching speed, the VME module achieves worst-case spurious performance of –60 dBc.

Many other synthesizer suppliers, including Elcom Technologies (Rockleigh, NJ) and Synergy Microwave (Paterson, NJ), have succeeded in blending DDS technology with clever circuit design to overcome traditional spurious limitations. One of the more innovative recent applications of DDS technology was by FEI Communications (Mitchel Field, NY) as a "correction circuit" for oven-controlled crystal oscillators (OCXOs). By employing DDS technology, the company's FE205A, FE-405A, and FE-505A OCXOs can approach the frequency stability of more expensive rubidium atomic clocks.

Of course, any discussion on DDS technology would be incomplete without mention of Sciteq Electronics. The company's synthesizer product lines, which were acquired by Osicom (itself renamed to Sorrento Networks), now can be found as part of the RF production lines of optical-communications-equipment supplier Meret Optical Communications (San Diego, CA). Although small, Sciteq achieved a great many landmarks in DDS development, constantly pushing clock frequencies and introducing the first GaAs-based DDS source.

DDS technology appears to have a promising future in this industry, although advances in more traditional synthesizer technologies, including PLL, fractional-N, and direct-analog technologies, are far from exhausted. In the end, synthesizer specifiers reap the benefits of this push for the ultimate RF synthesizer.

Jack Browne

Publisher/Editor

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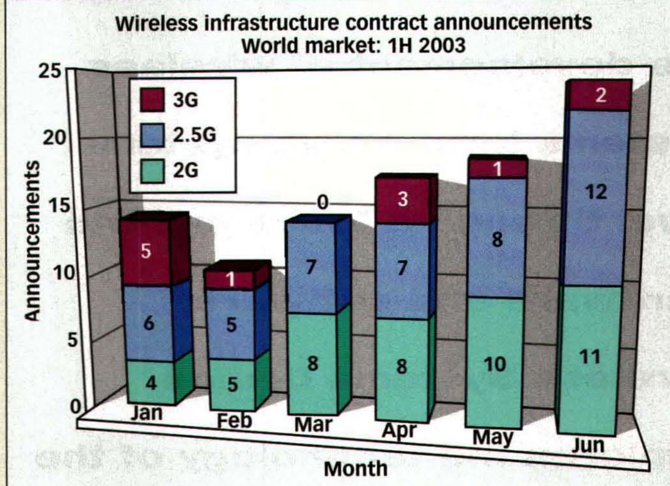
News items from the communications arena.

Wireless Infrastructure Contract Announcements Are Increasing

OYSTER BAY, NY—To satisfy consumer and enterprise demand for data, carriers will continue to deploy traditional cellular networks in the form of GPRS/WCDMA- and CDMA2000-based networks. Other carriers will deploy emerging technologies based on the IEEE 802.16 and 802.20 standards. According to technology research firm Allied Business Intelligence (ABI), infrastructure spending on these technologies will reach $16 billion by 2007. However, the vast majority of this will be spent on traditional cellular technologies, rather than WiMAX/802.16 or 802.20 equipment.

"Though WiMAX will play a significant role in the industry, the markets for traditional cellular networks will continue to dominate due to their ubiquitous nature," claims Edward Rerisi, ABI's director of research. "Until consumers and businesses demand ever-present fixed/portable broadband wireless coverage, 802.16/20 deployments will not be as extensive. This leaves the door open in the foreseeable future to traditional cellular networks."



(Source: Allied Business Intelligence, Inc.)

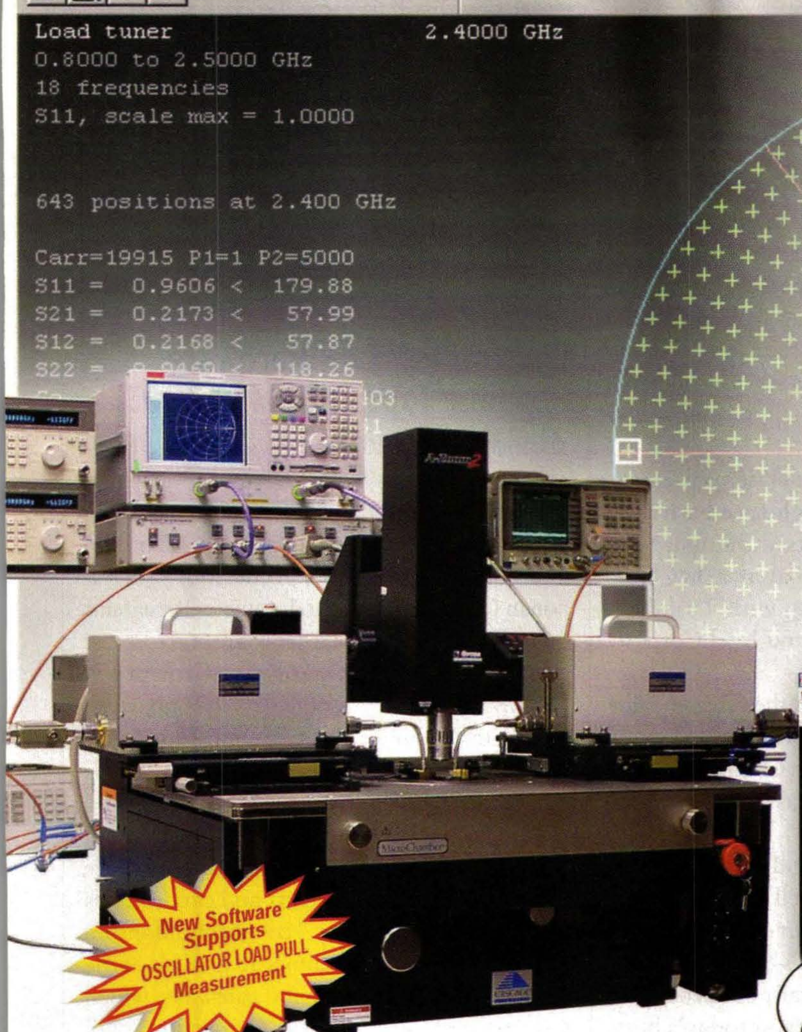
ABI projects that the market for WCDMA and CDMA 2000 1X EV-DO deployments will expand over 40 percent on a CAGR-basis over the next four years, eventually representing nearly 70 percent of the overall infrastructure market in 2007. For the first half of 2003, contract announcements have been on the rise **(see figure)**, indicating momentum for the equipment providers.

QUALCOMM Celebrates The 15th Anniversary Of OmniTRACS

SAN DIEGO, CA—QUALCOMM, Inc. has announced that it is celebrating the 15th anniversary of its OmniTRACS® satellite mobile communications system, a solution for real-time data communications, automatic vehicle tracking, and satellite positioning for the transportation industry. In the 15 years since OmniTRACS was introduced, QUALCOMM has shipped nearly 480,000 commercial units to businesses in 39 countries on four continents.

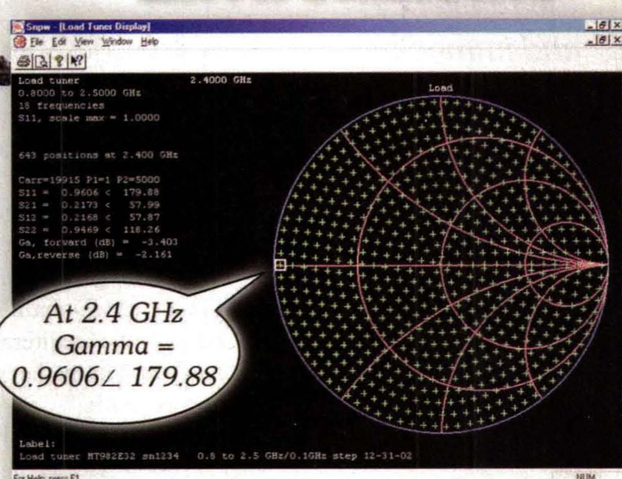
"It has been very exciting to witness OmniTRACS' contribution to the increased performance and improved efficiency of the transportation industry," comments Dr. Irwin M. Jacobs, QUALCOMM's chairman and CEO. "The success of the OmniTRACS mobile communications system, which makes use of both direct-sequence and frequency-hopped spread-spectrum technology, provided a foundation for the Company's development and commercialization of CDMA wireless technology. QUALCOMM remains focused on continuing the OmniTRACS model of stressing innovations in wireless digital communications that can have major impact on living standards and quality of life worldwide."

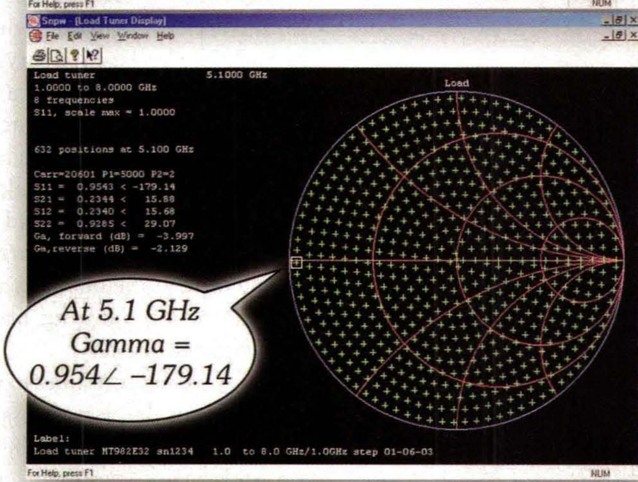
More than 1600 US truckload fleets and 2000 NAFTA truckload fleets depend on OmniTRACS and QUALCOMM's Network Management Center (NMC) to communicate with drivers, monitor vehicle location, and provide superior customer service. Fleet messages are sent via satellite through the NMC to dispatch centers throughout the US. The NMC processes more than seven million data transactions daily.



MAURY Automated Tuner Systems are Optimized for WLAN Applications in On-Wafer Environments

Maury MT982E32 tuners in a typical on-wafer setup.





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McDonald's Announces Largest Wi-Fi Launch To Date

CHICAGO, IL—McDonald's has announced the launch of high-speed wireless Internet access for customers in an anticipated 100 restaurants throughout the Chicagoland and Milwaukee areas, with more than 60 of those restaurants offering wireless services immediately. Additional locations will be completed by the end of September.

McDonald's is the first quick-service restaurant to offer customers high-speed wireless access in three major markets—Chicago, New York, and the San Francisco Bay area. In Chicago, McDonald's is working with Toshiba's Computer Systems Group and Intel Corp. to provide the service.

"We are literally connecting to the relevancy and immediacy of today's busy American way of life."

The restaurants chosen for the Chicago pilot program are in a variety of different communities, including 12 locations in Chicago, 44 locations in the Chicago suburbs, as well as five Milwaukee-area locations.

"This is a high-tech blend of innovation and convenience that will tell our customers McDonald's is going to be part of their world," states Phil Gray, McDonald's central division vice president. "We are literally connecting to the relevancy and immediacy of today's busy American way of life."

Toshiba's SurfHere high-speed wireless Internet access service is the key piece of the Chicago area McDonald's wireless program. The SurfHere by Toshiba service allows those with notebook computers and other wireless-enabled devices to connect to the Internet without cables or wires at participating McDonald's. With this wireless technology, business professionals, road warriors, students, tourists, and busy parents can stay in contact and handle business and other communication needs during breakfast, lunch, or throughout the day.

"As the nation continues to go mobile, public demand for wireless access points is experiencing phenomenal growth. Our agreement with McDonald's represents an essential element in building the Toshiba SurfHere foundation and in planning Toshiba's top-quality wireless Internet access for future success and industry leadership," says John Marston, director of business development at Toshiba CSG. "We are extremely excited with this opportunity to demonstrate Toshiba's SurfHere service now benefitting McDonald's customers who find it necessary to stay connected and productive while out of their home or office."

Intel Corp. and McDonald's have partnered throughout the entire Wi-Fi launch in New York, San Francisco, and Chicago.

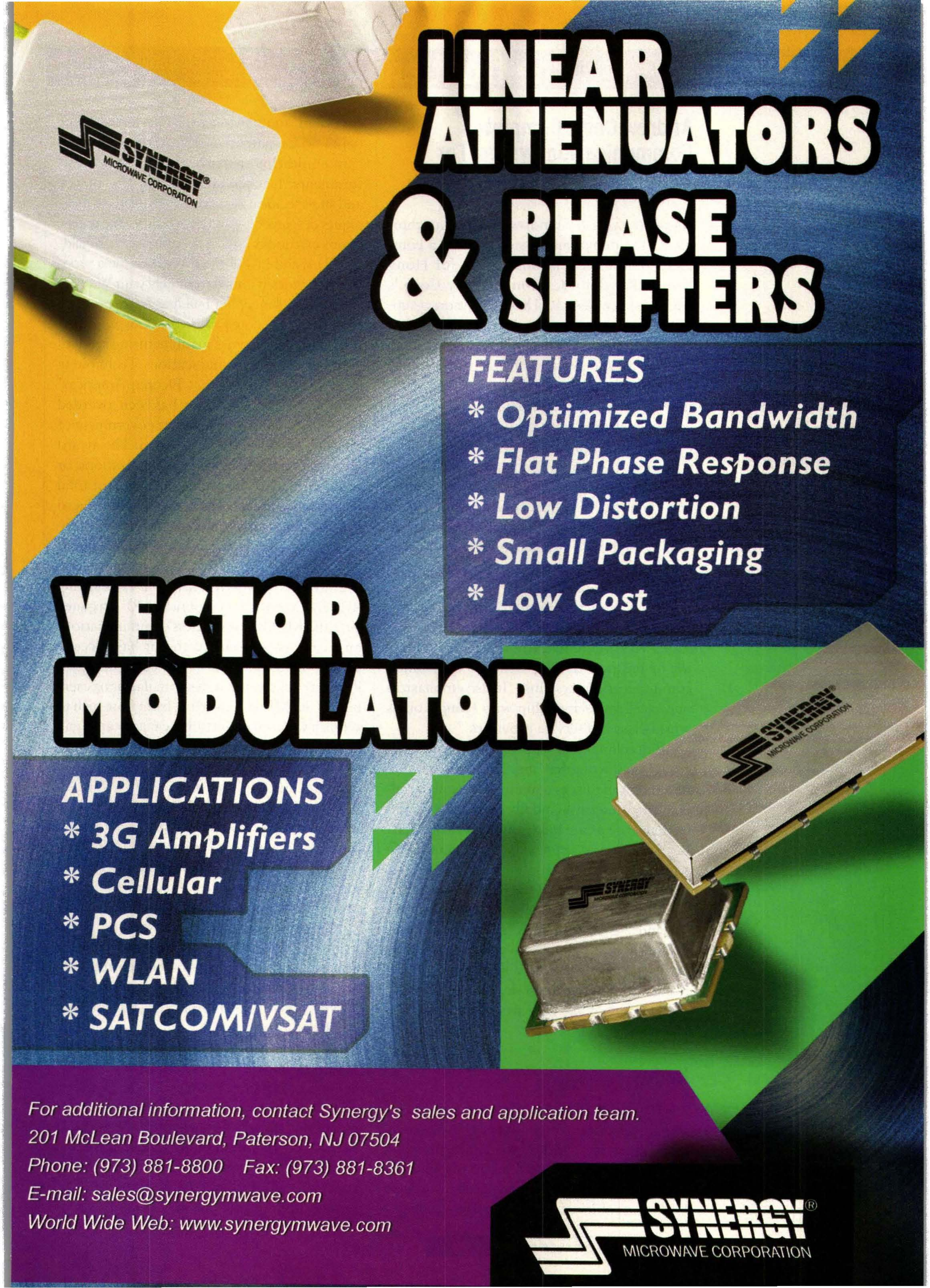
Worldwide WLAN Hardware Revenue Tops $608M In 2Q03

LONDON, ENGLAND—Worldwide wireless local-area-network (WLAN) hardware revenue topped $608 million in the second quarter of 2003, and is projected to grow to $3.2 billion in CY06, up about 100 percent from $1.6 billion in CY02, according to Infonetics Research's quarterly worldwide market-share and forecast service, Wireless LAN Hardware. Growth will be slow and steady over the next four quarters, mostly in the single digits, reaching $661 million in 2Q04.

"Wireless LANs will continue to show solid growth in all enterprise markets, and access point product vendors are beginning to differentiate between enterprise products and carrier-class access points for hotspots," comments Infonetics Research's Richard Webb, lead analyst of the report. "Wireless broadband gateways, which wirelessly enable cable/DSL connections, will also continue healthy growth, driven simultaneously by telecommuting for enterprises and multimedia entertainment applications, such as online gaming, for consumers."

"The service-provider public-access hotspot market will accelerate slowly through CY03," continues Webb. "It's a small market now, but hotspots are gaining rapid acceptance as an inexpensive way for service providers to drive service subscriptions for an increasingly mobile yet data-reliant workforce. Numerous service providers have indicated their intent to roll out hotspots, spurred on by advances in subscriber and network-management systems."

Wireless LAN Hardware tracks WLAN access points in three function-based categories (standalone, wireless broadband gateways, bridges), and network-integration cards (NICs) in three categories (USB, PCI, and PCMCIA cards). Access points and NICs are broken out by 802.11a vs. 802.11b vs. 802.11g, and the WLAN hardware revenue total is broken out by enterprise vs. consumers vs. service providers. Standalone access points are broken out by SOHO/consumer vs. service provider/enterprise.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Andrew Corp. Completes Communication System For Hong Kong Rail Line

ORLAND PARK, IL—Andrew Corp. has completed the design and installation of a commercial communications system for Hong Kong's Kowloon-Canton Railway Corp.'s (KCRC's) new West Rail line. The Andrew-supplied distributed communications equipment carries the RF signal along the entire line, including tunnels and stations. As a result, commuters traveling on the new 30.5-km (19-mile) Nam Cheong to Tuen Mun line experience uninterrupted calls on their mobile phones.

Andrew supplied and installed EOCell™ fiber-optic distribution equipment, RADIAX® radiating cables, and HELIAX® coaxial cables and connectors to boost coverage in the West Rail line's nine stations and along part of the track. Amplifiers, installed in the tunnels, provide total coverage for mobile phones and other devices.

"This contract completion is a great endorsement of the quality of our products and service," states Vick Mamlouk, Andrew Corp.'s director of business development for distributed communications systems. "It also emphasizes our excellent relationship with Hong Kong's world-class rail service providers."

With cellular market penetration of 93 percent, Hong Kong has more than six million mobile-phone users—many are regular railway commuters. As a daily average, 817,790 passenger trips are made on the KCRC's East Rail service, and approximately 313,600 passengers use its Light Rail service.

"We are proud that the KCRC has chosen Andrew to provide a high-quality, cost-effective wireless infrastructure," says Simon Leung, Andrew Corp.'s project director for the KCRC project. "Our systems will enhance Hong Kong's commuters' lifestyle, enabling them to stay in touch while they are on the move."

"Our systems will enhance Hong Kong's commuters' lifestyle, enabling them to stay in touch while they are on the move."

Kudos

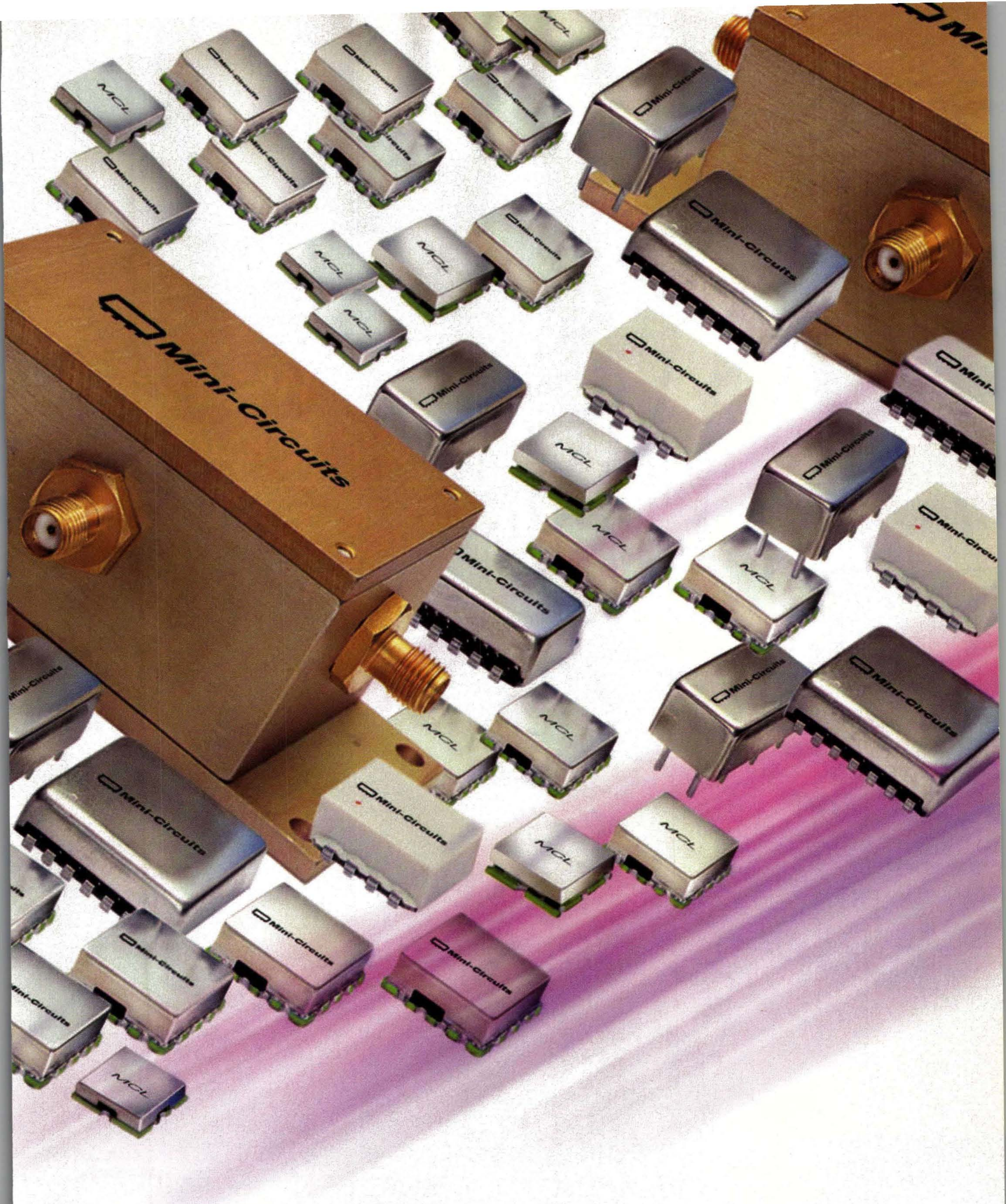
AUSTIN, TX—Wireless Valley Communications, Inc., a developer of products and technical training services for the design, measurement, and management of in-building and campus networks, announced that it has been awarded a US Patent for its wireless site-survey and measurement acquisition products. US patent 6,422,507, a patent in the field of in-building communication systems and network measurements, teaches fundamental site-survey and site-specific measurement acquisition techniques developed by Wireless Valley. The patent covers inventions used in the InFielder®, InFielder® PDA, and LANFielder® measurement products that work within or remotely with Wireless Valley's SitePlanner® in-building design product.

IRVING, TX—Elcoteq Network Corp., global provider of electronics manufacturing services (EMS) for the Communications Technology industry, announced that Elcoteq Americas' Monterrey, Mexico facility has been awarded the 2003 Quality Award by the government of the state of Nuevo Leon, Mexico. The award recognizes those institutions, organizations, or companies who have achieved a level of total quality management. The PNLC (Premio Nuevo Leon a la Calidad) is the equivalent of the European Foundation for Quality Management Award or the Malcom Baldridge Quality Award.

GREENSBORO, NC—RF Micro Devices, Inc. (RFMD), a provider of proprietary RF integrated circuits (RF ICs) for wireless communications applications, announced that it has successfully completed its first major customer qualification of its six-inch wafer-manufacturing capabilities. RFMD is converting from four-inch to six-inch wafer-manufacturing capacity at its gallium-arsenide herterojunction-bipolar-transistor (GaAs HBT) fabrication facility, which is located in Greensboro, NC.

RICHARDSON, TX—Anritsu Co. announced that it has recently received approval on an additional 10 RF test cases from the GCF (Global Certification Forum), giving the company a total of 50 GCF-approved test cases, the largest of any test-equipment provider. The recent approval further solidifies Anritsu's commitment to 3G, and provides mobile operators and UE (used-equipment) manufacturers with a single source for virtually any test requirement.

WARREN, NJ—ANADIGICS, Inc., a supplier of wireless and broadband communications solutions, has been granted its third patent for the development of a wireless multiband amplifier circuit. US Patent No. 6,501,331 was granted for the development of a gallium-arsenide monolithic-microwave-integrated-circuit (GaAs MMIC) dual-band amplifier for use in wireless handsets for operation at either 800 MHz or the 1900-MHz band to provide gain and input/output impedance. MRF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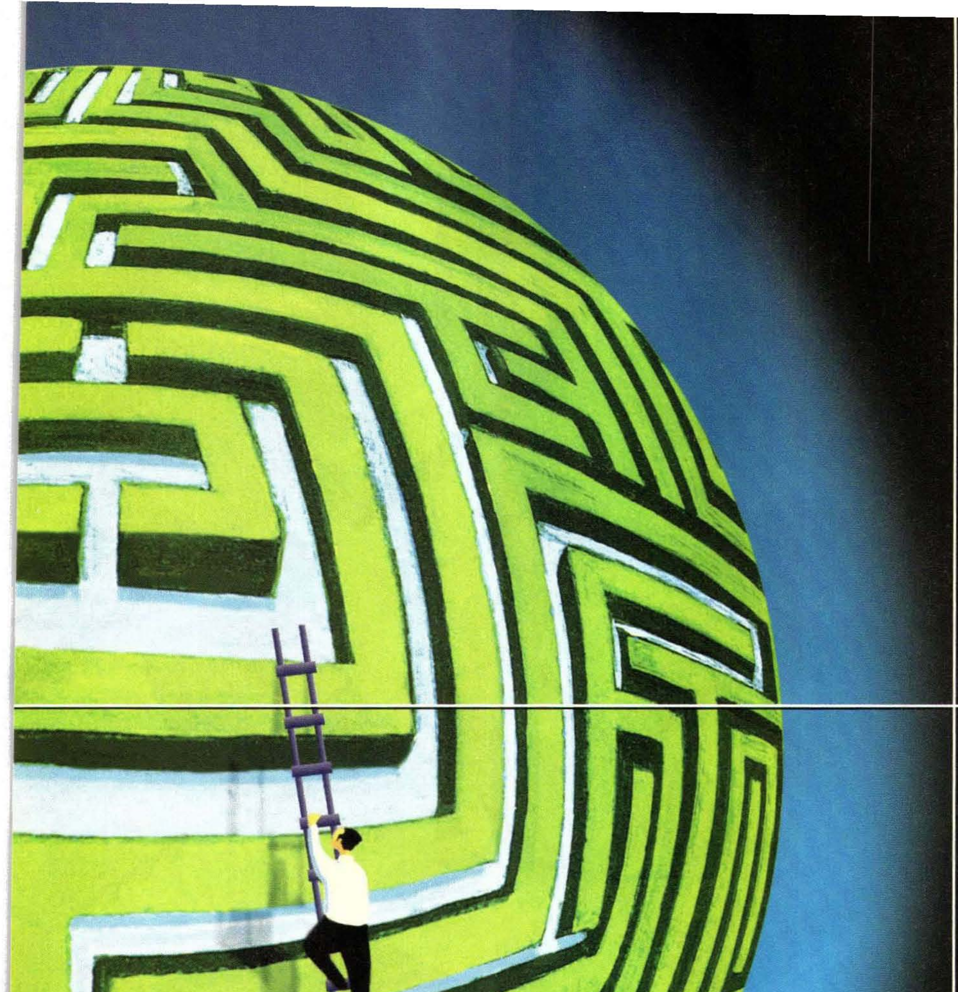

Frequency Synthesizers Yield Stable Signals

Analog and digital frequency synthesizers are available in a variety of shapes, sizes, and technologies, depending on the requirement.

JACK BROWNE
Publisher/Editor

Frequency synthesizers are used throughout commercial and military systems, in designs as large as complete radar systems and as small as cellular telephones. Based on the number of companies competing for the many markets served by frequency synthesizers (a general search of the Internet will reveal more than 40 suppliers), the demand for synthesized sources with a wide range of performance levels is growing, as tuning in high-frequency systems is now dominated by digital approaches (tuning frequencies in discrete steps) rather than earlier analog (continuous tuning) methods.

Synthesizers are available in physical configurations ranging from packaged integrated circuits (ICs) to moderate-sized modules and hybrid circuits to larger rack-mountable system-type synthesizers complete with power supplies and supporting digital monitoring and communications circuitry. Because of the limited scope of this article, it will focus on modules, racks, and instrument-grade frequency synthesizers, with a future article providing details on available IC-level synthesizers.

Various technologies are used in modern frequency synthesizers, including traditional sources based on phase-locked-loop (PLL) technology to lock the phase of a voltage-controlled oscillator (VCO) to that of an inherently more stable reference source, such as a temperature-compensated crystal oscillator (TCXO) or an oven-controlled crystal oscillator (OCXO). Such synthesizers can be designed with a single loop for optimal frequency switching speed, or with multiple loops when lower noise performance is required. In essence, they can be called "integer-N" synthesizers where N is the multiplication factor used to determine the output frequency as a multiple of the reference source frequency.

In recent years, newer synthesizer technologies have gained in popularity, including fractional-N frequency synthesizers, which use non-integer values for N, and direct-digital synthesizers (DDS), which rely on the conversion of 32-to-48-b phase/frequency/amplitude digital data into analog output signals through the use of precision accumulators and digital-to-analog converters (DACs). Fractional-N synthesizers can achieve phase-noise levels that are very close to the reference source, although they tend to be limited in bandwidth. A DDS features nanosecond frequency switching speed, but is traditionally limited in spurious performance by the bit resolution of certain of its digital components, and limited in frequency by the clock rates of available digital components.

A DDS is an example of a "direct syn-

thesis" technique, in which an output signal is created as a one-to-one function of an input digital word. A large number of digital words that define signal phase (frequency) and amplitude can be stored in memory and pipelined to a DDS, allowing high-speed frequency switching and execution of such functions as frequency hopping and generation of complex chirp signals. Direct synthesizers can also be realized by means of analog circuitry by generating, for example, a comb of frequencies and then filtering to select the desired output frequency. While this approach offers switching speeds similar to that of a DDS, the amount of filtering needed for high-frequency and broadband coverage leads to a design that is complex and expensive.

In some cases, such as the MTS2000-DS multiloop frequency synthesizer from Synergy Microwave Corp. (Paterson, NJ), several technologies are combined in one package. This multiloop PLL frequency synthesizer that also employs DDS technology to achieve extremely small step sizes with relatively fast switching speed. This compact module (10.16 × 10.16 × 2.54 cm) tunes from 1 to 2 GHz in step sizes as small as 1 Hz and with phase noise of –94.97 dBc/Hz offset 1 kHz from the carrier (see *Microwaves & RF*, August 2003, p. 92).

Another company that combines analog and digital frequency-synthesis techniques is Elcom Technologies (Rockleigh, NJ), with their UFS series of products. These larger, rack-mount synthesizers are available in narrowband and wideband models through 18 GHz suitable for radar, surveillance, electronic-warfare (EW), and ATE applications. For example, the company's model UFS-15 synthesizer tunes from 1.2 to 3.6 GHz and from 9.6 to 15.0 GHz (two separate output ports per a customer's request) with 1-Hz frequency resolution and 200-ns switching speed. Although DDS sources are traditionally guilty of high levels of spurious content, this synthesizer achieves spurious levels of –67 dBc from 1.2 to 3.6 GHz and –70 dBc from 9.6 to 15.0 GHz. Harmonics are as low as –80 dBc, and single-sideband (SSB) phase noise is a mere –110 dBc/Hz offset 100 Hz from a 12-GHz carrier, –116 dBc/Hz offset 1 kHz from the same carrier, and dropping to –142 dBc/Hz offset 10 MHz from the 12-GHz carrier (a more complete review of the UFS-15 will be available in the November issue).

A long-time supplier of DDS sources, ITT Industries, Microwave Systems (Lowell, MA), which has built upon technology developed by Stanford Telecom during the 1980s and 1990s, offers several lines of DDS-based frequency synthesizers. The firm's WaveCor synthesizers, for example, features sources oper

ating in bands from 50 MHz to 20 GHz with spurious levels of less than –80 dBc and phase noise of –140 dBc/Hz offset 10 kHz from the carrier. Capable of switching frequencies in less than 200 ns, these high-performance sources are housed in a compact, six-inch cube.

In contrast, Advanced Radio Corp. (Reston, VA) is a newcomer on the list of synthesizer suppliers (see *Microwaves & RF*, April 2003, p. 94). The firm's ADV-3000S synthesizer module leverages DDS technology to achieve low phase noise and spurious performance of better than –90 dBc from 20 MHz to 3 GHz, with optional coverage to 18 GHz. The fast-switching synthesizer is well suited as a programmable LO for radar, signal-intelligence (SIGINT), and electronic-warfare (EW) applications. Through the use of innovative spurious-concealing circuitry, the company's engineers have managed to suppress DDS spurious noise by more than 30 dB compared to traditional DDS filtering methods.

Although advances occur quickly with digital synthesizer approaches, improvements are also being made with analog technologies. Micro Lambda Wireless (Fremont, CA), for example, bases its low-noise synthesizers on its building-block YIG oscillator technology, offering both wideband and narrowband frequency synthesizers. Its wideband models, for example, are suitable for use as LOs in communications equipment or a signal sources in test equipment. The MLSW wideband series includes the 0.6-to-3.0-GHz model MLSW-0603, the 2-to-8-GHz model MLSW-2080, and the 2-to-10-GHz model MLSW-2010. The synthesizes feature 1-Hz frequency resolution, power levels of +10 to +12 dBm, and spurious levels of –60 dBc. The phase noise is typically –100 dBc/Hz offset 1 kHz from the carrier and –108 dBc/Hz offset 10 kHz from the carrier. At a 1-MHz offset, the phase noise for the 3-GHz synthesizer is –140 dBc/Hz, with levels of –138 dBc/Hz from the 8-GHz synthesizer and –135 dBc/Hz for the 10-GHz unit. The synthesizers, which measure 7 × 5 × 1 in. (17.78 × 12.7 × 2.54 cm) and consume only 29 W, achieve full-band tuning in 13 to 18 ms, and tune across a 100-MHz step in only 10 ms.

The company's newly expanded MLSN series of narrowband synthesizers now includes models operating in 2-GHz bands from 2 to 16 GHz. These sources, which feature similar or improved phase-noise performance compared to the wideband MLSW models, also tune in 1-Hz steps and achieve better than +10 dBm output power through 9 GHz and better than +8 dBm output power through 16 GHz. As an example, the highest-frequency model, the 14-to-16-GHz MLSN-1416, features 1-Hz frequency resolution and 12-ms full-band tuning speed. Spurious noise is typically –60 dBc while phase noise is –94 dBc/Hz offset 1 kHz from the carrier, –101 dBc/Hz offset 10 kHz from the carrier, and –135 dBc/Hz offset 1 MHz from the carrier.

Another company that espouses the use of YIG technology in its frequency synthesizers is Endwave Corp. (Sunnyvale, CA). The firm offers compact modular frequency synthesizers in bands as wide as 2 GHz from 4.5 to 14.0 GHz with phase noise as low as –100 dBc/Hz offset 10 kHz from the carrier. For example, the company's 50 Series includes the 4.5-to-7.0-GHz model SYN-50A-00 and the 7-to-10-GHz model SYN-50B-00. Both tune over a 1500-MHz tuning range in 125-kHz steps with phase noise of –100 dBc/Hz offset 10 kHz from the carrier, dropping to –143 dBc/Hz offset 1 MHz from the carrier. The typical output power is better than +10 dBm for both models, and spurious content is typically less than –70 dBc. The 50 Series synthesizers measure 3.9 × 3.12 × 1.38 in. (9.9 × 7.9 × 3.5 cm).

Endwave's 20 Series includes the 7.9-to-8.4-GHz model SNY2018E and the 8.0-to-8.3-GHz model SYN2018F. These models tune with maximum step sizes of 27.5 and 20 MHz, respectively, achieving spurious levels of –70 dBc. The sources feature +10 dBm output power and have phase noise levels of –85 dBc/Hz offset 10 kHz from the carrier and –140 dBc/Hz offset 1 MHz from the carrier. They measure 6.25 ×2.98 × 1.1 in. (15.9 × 7.6 × 2.8 cm).

TRAK Microwave Corp. (Tampa, FL) is another well-known supplier of high-speed frequency synthesizers, employing both direct and indirect analog synthesis techniques. An example of a direct analog unit is a 7-to-9-GHz model with 1-MHz step size and 500 ns maximum switching speed. The synthesizer employs a bank of crystal oscillators, which undergo frequency conversion, switching, and filtering to generate the final output frequencies. This synthesizer generates relatively high output power of +19 dBm with spurious levels of –60 dBc, and phase noise of –110 dBc/Hz offset 10 kHz and –120 dBc/Hz offset 1 MHz from the carrier. The unit, which includes a power supply, measures 15 × 8.5 × 5 in. (38.1 × 21.6 × 12.7 cm).

The company's indirect analog synthesizers are based on selecting and filtering frequencies from a comb generator. The firm's lineup includes a 575-to-1075-MHz synthesizer capable of better than 100-ns switching speed. Although possessing large frequency steps (25 MHz), the source boasts good phase noise, with performance of –110 dBc/Hz at 1 kHz offset, –130 dBc/Hz at 10 kHz offset, and –140 dBc/Hz at 10 MHz offset from the carrier. The synthesizer measures 6.5 × 4.6 × 0.95 in. (16.51 × 11.7 × 2.4 cm).

Communications Techniques, Inc. (Whippany, NJ) is a veteran supplier of microwave frequency synthesizers, offering one of the larger varieties of package styles of synthesizer topologies. For example, the company's Series DS synthesizers are rack-mount, instrument-grade synthesizers capable of achieving a full tuning range of 0.005 to 20.48 GHz in a single unit. Available as a rack-mount or modular unit, the DS synthesizers feature typical switching speeds of 0.3 to 1 μs, frequency steps as small as 1 Hz, and +13 dBm output power. The direct analog frequency synthesizers achieve spurious levels of –64 to –80 dBc, depending upon frequency. The SSB phase noise is –109 dBc offset 1 kHz from a 10-GHz carrier, –119 dBc/Hz offset 10 kHz from the same carrier, and –128 dBc/Hz offset 1 MHz from the same carrier. For a 1-GHz carrier, the phase noise is –127 dBc/Hz offset 1 kHz, –137 dBc/Hz offset 10 kHz, and –147 dBc/Hz offset 1 MHz.

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WaveCor Synthesizers use advanced proprietary digital techniques to produce signals from 50 MHz to 20 GHz, delivering the industry's best combination of ultra-fast switching, precise tuning, low phase noise and high spurious free dynamic range. This unparalleled performance is coupled with a flexible architecture, enabling solutions to be precisely tailored to your needs. The result? The best synthesizer value in the market today.

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The company's broadband Series BBS synthesizers includes models covering as wide as 0.01 to 5.12 GHz in a single unit with step sizes from 1 Hz to 10 MHz. The typical phase noise is –131 dBc/Hz offset 100 kHz from a 1-GHz carrier, while spurious levels range from –63 to –85 dBc, depending upon frequency. These compact synthesizers measure just 3.6 × 5.8 × 0.98 in. (9.1 × 14.7 × 2.5 cm), excluding connectors, and deliver output levels from +13 to +17 dBm.

Another long-time supplier of frequency synthesizers, MITEQ (Hauppauge, NY), offers frequency synthesizers to 40 GHz. The company's SLS Series is optimized for fast switching applications including wireless-communications and satellite-communications systems, while the MFS series provides extremely low phase noise for critical satellite communications applications. The firm's unique CFS series of synthesizers offers dual output signals for systems requiring dual upconversion or downconversion. These synthesizers provide output signals in Ku-band (12.710 to 13.280 GHz) and L-band. The synthesizers switch in 125-kHz steps with +13 dBm output power with –70 dBc spurious content.

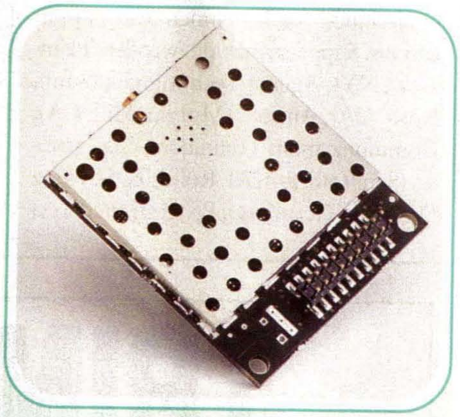
A long-time supplier of instantaneous-frequency-measurement (IFM) receivers, and user of frequency synthesizers, is now also a supplier: Wide Band Systems (Rockaway, NJ). The company's model PS-070-180A tunes from 7 to 18 GHz in 1-MHz steps and offers at least +13 dBm output power. It settles to a new frequency in 100 μs or less and boasts spurious levels of –50 dBc or better. The SSB phase noise is typically –60 dBc/Hz offset 1 kHz from the carrier, –65 dBc/Hz offset 10 kHz from the carrier, and –110 dBc/Hz offset 1 MHz from the carrier. The synthesizer measures 4 × 4 × 8 in. (10.16 × 10.16 × 20.32 cm).

The frequency synthesizers mentioned above rely on digital commands from a control bus for executing frequency and amplitude changes, making many of them suitable for automatic-test-equipment (ATE) applications. Some test applications, however, require a more flexible local interface for control, as evidenced by another class of frequency synthesizer designed for instrumentation applications. Suppliers include Aeroflex (Plainview, NY), Agilent Technologies (Santa Rosa, CA), Anritsu (Morgan Hill, CA), Communications Techniques, Giga-tronics (San Ramon, CA), Rohde & Schwarz (Munich, Germany), Programmed Test Sources (Littleton, MA), and Universal Microwave Corp. (Odessa, FL, see p. 55). For more information on these and other suppliers of frequency synthesizers, please refer to the *Microwaves & RF Product Data Directory* website at www.m-rf.com. MRF

Module Replaces Wires With 868-MHz Links

MILES OF CABLES in harsh environments can be replaced easily with the AC4486 transceiver module. The module interfaces to other designs by means of serial TTL connections for efficient, bidirectional communications at data rates to 115.2 kb/s. The transceiver module is available in two versions: model AC4486-5, which operates from 869.7 to 870.0 MHz, and model AC4486-500, which operates in dual frequency bands of 868 to 870 MHz and 902 to 928 MHz. The single-frequency module consumes about 35 mA typical current on transmissions while the dual-frequency unit consumes 200 mA typical current during transmissions; current consumption is less in both cases for reception.

AeroComm, 10981 Eicher Dr., Lenexa, KS 66219; (913) 492-2320, FAX: (913) 492-1243, Internet: www.aerocomm.com.



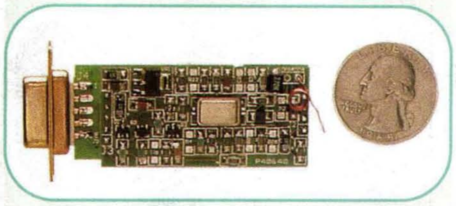
AEROCOMM'S AC4486 TRANSCEIVER MODULE

DOW-KEY'S MODEL 401A-630832 FAILSAFE SMA SWITCH

Failsafe SMA Switch Handles 200 W Power

DESIGNED TO WITHSTAND high-shock environments, the model 401A-630832 single-pole, double-throw (SPDT) failsafe SMA switch is suitable for applications from DC to 18 GHz. It can handle as much as 200 W CW input power from DC to 4 GHz, as much as 160 W CW input power from 4 to 8 GHz, and at least 90 W CW input power from 8 to 18 GHz. Maximum insertion loss is 0.15 dB from DC to 4 GHz, reaching a maximum of 0.45 dB from 12 to 18 GHz. The minimum isolation between ports is 80 dB from DC to 4 GHz, 70 dB from 4 to 8 GHz, 65 dB from 8 to 12 GHz, and 60 dB from 12 to 18 GHz. The switch, which can handle peak power levels exceeding 400 W, is designed to withstand mechanical shock of 100 G's for 6 ms and pyrotechnic shock levels to 2000 G's.

Dow-Key Microwave Corp., 4822 McGrath St., Ventura, CA 93003-7718; (805) 650-0260, (805) 650-1734, Internet: www.dowkey.com.

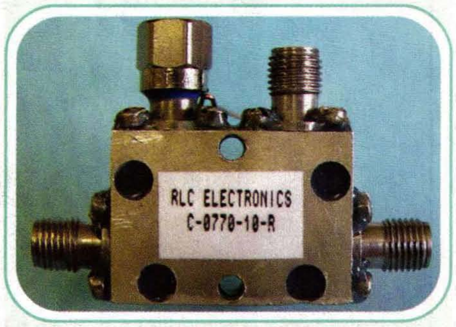


OTEK CORP.'S TRANSCEIVER MODULE MODEL TR200

Wireless Transceiver Operates At 915 MHz

LOW-COST TRANSCEIVER module model TR200 is ideal for stationary wireless transmission and reception (two units are required) of process control and telemetry data at rates to 19.2 kb/s. The transceiver operates in the 916.5-MHz unlicensed industrial-scientific-medical (ISM) band and can achieve operating ranges of 100 ft. indoors and 300 ft. outdoors. Digital input/output (I/O) connections include RS-232C, 485, and TTL connections. The transceivers, which employ on-off-keying (OOK) or amplitude-shift-keying (ASK) modulation, operate with peak transmitter power of 1 mW. The transceiver measures only 1.85 × 1.85 × 0.4 in.

OTEK Corp., 4016 E. Tennessee St., Tucson, AZ 85714-2130; (520) 748-7900, FAX: (520) 790-2808, e-mail: sales@otekcorp.com, Internet: www.otekcorp.com.



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RLC Electronics, Inc., 83 Radio Circle, Mount Kisco, NY 10549; (914) 241-1334, FAX: (914) 241-1753, e-mail: sales@rlcelectronics.com, Internet: www.rlcelectronics.com.


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Mimix Secures $6.7M In Funding

MIMIX BROADBAND, INC., a fabless semiconductor company for wireless communications, announced that it has secured $6.7 million in an initial close of its second round of institutional funding. This round of funding was led by 3i, an international venture capital company, and First Capital Group of San Antonio, TX. The majority of existing shareholders also participated in this round. Proceeds will be used to expand Mimix's product portfolio of highly integrated and high-power monolithic microwave integrated circuits (MMICs).

Mimix designs, develops, and supplies MMIC solutions for the microwave and millimeter-wave wireless-communications markets. Mimix has assembled a team of scientists experienced in the design of highly integrated and high-power semiconductor devices, as well as complete communications systems design.

"The commitment received from our investors for this round of funding confirms the confidence our shareholders have in Mimix to achieve success as a long-term supplier of MMIC solutions," says Arthur Epley, Mimix's chairman of the board. "We are pleased with the progress that Mimix is making, and feel fortunate to have these world-class investors supplying deep resources and expertise and supporting our growth efforts."

"This second round of institutional funding led by 3i and First Capital Group allows us to aggressively continue building out our product portfolio and serving our expanding list of customers," states Rick Montgomery, CEO of Mimix. "Our strategy is to provide industry-leading, high-power, and multifunction MMIC devices designed for superior performance. We see our MMIC products as revolutionary technology that is enabling market growth."

"As a returning co-lead investor, First Capital Group remains enthusiastic about Mimix's future and its ability to successfully execute its business plan," comments Jeff Blanchard of First Capital Group. "Our investment in Mimix reflects how delighted we are with the progress that Mimix has made over the past two years." MRF

CONTRACTS

QUALCOMM, Inc.—Announced that they and Science Applications International Corp. (SAIC) have been awarded a $2 million contract from the US Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) for the development and field testing of an untethered trailer asset-management system for high-value or high-security-risk loads. The system will provide sophisticated on-board hardware, advanced power management, network services, and extensive data-integration capabilities using state-of-the-art, tri-mode (digital cellular, PCS, and analog) communications. QUALCOMM and SAIC were one of three teams solicited to submit proposals in FMCSA's Request for Proposal process in early July.

Herley Industries, Inc.—Received multiple contracts totaling $1.7 million to supply microwave hardware for US Missile Defense applications. The contracts include standard Herley products as well as requirements for Herley to design and develop application-specific hardware.

FRESH STARTS

RF Logic, LLC—Announced the appointment of Advanced Communications as their exclusive representative in the Northern California territory. RF Logic is a supplier of coaxial-cable assemblies and custom test equipment and components to both the RF microwave and high-speed digital markets.

Trompeter Electronics—Has begun systematically relocating its California manufacturing operations to Mesa, AZ. Mesa is the headquarters of Semflex, a sister company to Trompeter.

Cookson Electronics Equipment [CEE] (also known as Speedline Technologies, Inc.)—Announced that it has entered into an exclusive partnership with MMI Systems Pte Ltd. for the manufacture of certain MPM stencil printers. The deal has been concluded after an intensive search to find a partner in the Asian marketplace that will provide customers with added capacity, delivery, service, and competitive pricing. The new facility will be located in the Suzhou Industrial Park in the Shanghai region of China.

Rosenberger OSI Fiber Optics—Recently established a North American presence by opening a sales, engineering-support, and distribution facility in Lancaster, PA. Rosenberger OSI Fiber Optics is a division of Rosenberger of North America, LLC, a supplier of coaxial connectors and cable assemblies. Dr. Stephen Sacco is the technical director for the new fiber-optics division.

In addition to Lancaster, PA, Rosenberger OSI Fiber Optics also has facilities in Germany, Hungary, Brazil, and China.

MEMGen Corp.—Has changed its name to Microfabrica, Inc. The name change is effective immediately. It was implemented in order to more accurately represent the company's microdevice manufacturing capabilities.

Dynaloy, Inc.—Announced the recent opening of a direct field sales office in Taiwan to support growth in the customer base located in the region.

Texas Instruments Radio Frequency Identification (TI-RFid™) Systems—Has named Digi-Key Corp. of Thief River Falls, MN as an authorized distributor of TI-RFid products for the Americas. Digi-Key has added Texas Instruments RFid Systems' full line of low-frequency and high-frequency transponders and readers, integrated circuits (ICs), reader ASICs, and RFID Evaluation Kits to its line of product offerings.

The agreement with Digi-Key extends the distribution of TI-RFid products to design engineers who are building RFID-based systems. Texas Instruments' RFID products are used in a variety of applications, including automotive security, vehicle and personnel access control, product and asset tracking, wireless payment, sports timing, product authentication, ticketing, document management, and supply-chain tracking.

Universal Microwave Corp. (UMC)—Announced the opening of UMC's new Worldwide Sales and Customer Support Center. The new facility in Tempe, AZ will produce enhanced and expanded sales and customer service support for UMC's customers, representatives, and distribution network. The contact information for UMC's Worldwide Sales and Customer Support Center is: 4703 S. Lakeshore Dr., Suite #2, Tempe, AZ 85282; (480) 756-6070, FAX: (480) 756-6026, e-mail: sales@vco1.com.

Andrew Corp.—Announced that the 2004 Lincoln Aviator luxury Sports Utility Vehicle (SUV) is using an Andrew concealed Global Positioning System (GPS) antenna as an integral part of the vehicle's navigation system. Using GPS and map-matching technologies, the Lincoln Aviator's DVD-based navigation system can pinpont the vehicle's location (to within a 10-ft. radius) and guide the driver to the destination with easy-to-read visual directions on a 6.5-in.(16.5-cm) color touch-screen display. When integrated with the vehicle's sound system, the navigation system also imparts turn-by-turn audio directions.

The Andrew GPS Antenna System used on the Lincoln Aviator is a low-profile design, with an output signal matched to give the navigation system optimal performance. The Andrew ceramic patch antenna with its low-noise amplifier provides a 26-dB signal gain for tracking space-based satellites that determine the vehicle's location. The antenna is concealed beneath the vehicle's dashboard. To ensure ease and accuracy of installation, the Andrew antenna is mounted integrally on the vehicle's instrument panel assembly. The DVD Navigation System is a factory-installed option on the Lincoln Aviator.

Andrew also supplies GPS antennas for Lincoln's 2004 Navigator SUV, Town Car, and LS vehicles. Andrew provides concealed and roof-mount GPS antennas for Jaguar and Land Rover Discovery Vehicles. MRF


DC-2GHz
HAT
DC-6GHz
VAT


VOHRER

Rohde & Schwarz Appoint Vohrer As President & COO

Rohde & Schwarz GmbH & Co. KG has named MICHAEL VOHRER to the position of president and COO. Prior to taking on his current role, Vohrer served as executive vice president and head of the Test and Measurement Division.

RF Logic, LLC—ARTHUR E. BUTTS to director for new business development; formerly employed in global sales, marketing, and operations positions.

Park Electrochemical Corp.—MURRAY O. STAMER to CFO and senior vice president; formerly senior vice president for finance. Also, STEVEN P. SCHAEFER to senior vice president for technology; formerly vice president of business development.

Recognition Source—TRAY RAYMOND to the position of regional sales manager for the Southwestern sales region; formerly director of new business development for Senercomm.

ADC—ROBERT E. "BOB" SWITZ to president and CEO; formerly president and general manager of ADC's Broadband Access and Transport group. Also, JOHN A. "GUS" BLANCHARD to non-executive chairman of the board; remains as an ADC board member.

Arrowhead Global Solutions—MAJOR GENERAL HOWARD J. "MITCH" MITCHELL, USAF (RET.) to the position of vice president for Western operations; previously served 30 years in the US Air Force, retiring in July 2003.

Raltron Electronics Corp.—STANLEY VOGT to general manager for Raltron's US manufacturing operations in Miami, FL; formerly plant manager for Flextronics in Memphis, TN. Also, CHUCK HUSTED to engineering director; formerly employed in engineering management at NDK. In addition, SCOTT STEMPER to vice president of worldwide quality assurance; formerly director of quality.

Dynaloy, Inc.—NICK LEONARDI to director of sales and marketing for the Semiconductor Materials Division; formerly worldwide sales manager for Tiros Corp.

Maury Microwave Corp.—RUSTY MYERS to the engineering team to lead the development of Maury's microwave component line; formerly developed microwave components at Agilent Technologies.

Proxim Corp.—DAVID L. THOMPSON to CFO; formerly CFO at Entrust, Inc.

Zyray Wireless—THOM F. DEGNAN to senior vice president of sales; formerly president and COO of Verticalband Ltd.

Andrew Corp.—KAREN A. QUINN-QUINTIN to vice president and chief human resources officer; formerly vice president of human resources for Textron International Products. Also, CHARLES R. NICHOLAS to chairman of the board; formerly vice chairman and CFO.


NICHOLAS


HENDRY

ITT Industries, Cannon—ALLAN W. HENDRY to director of sales for the Americas; formerly worked in sales management in the connector industry.

Universal Microwave Corp. (UMC)—STEVEN C. REVERT to vice president of sales and marketing located in the Tempe, AZ Worldwide Sales and Customer Support Center; formerly vice president of the RF Power Product Business Unit for the Avnet RF and Microwave Division. MRF

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November 7 *Project Risk and Opportunity Management*
November 12-14 *Wireless Sensor Networks and Their Tactical Applications*
November 17-21 *Communication Systems Using Digital Signal Processing*
December 1-2 *Automatic Test Equipment (ATE) Selection, Design, and Programming*
December 3-5 *Design for Testability and Embedded Self Test*
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March 25-26, 2004 (Pasadena, CA)
Course Location: California Institute of Technology Industrial Relations Center
For further information, contact:
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Industrial Relations Center, I-90
Pasadena, CA 91125-9000
(626) 395-4043, FAX: (626) 795-7174
e-mail: execedu@caltech.edu
Internet: www.irc.caltech.edu

Active Phased Array Antenna Design, Development and Manufacturing
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Hyatt Regency Baltimore
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Phased Array Technology
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Ellicot City, MD 21042-1663
(410) 480-9570, FAX: (410) 480-9570
e-mail: patcorp@comcast.net

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November17-18 (Dulles, VA)
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November 19-20 (Dulles, VA)
Advanced Synthetic Aperture Radar (SAR)
November 18-20 (Arlington, VA)
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Clarksville, MD 21029
(888) 501-2100, FAX: (410) 531-1013
e-mail: ati@aticourses.com
Internet: www.aticourses.com/schedule.htm

▸MEETINGS

ARMMS RF & Microwave Society
November 3-4 (Rockingham, Corby, Northamptonshire, England)
Hotel Elizabeth
For further information, contact:
J.J. Heath-Caldwell
01962 761 565
e-mail: jj@jjhc.co.uk
Internet: www.armms.org

25th Annual IEEE GaAs IC Symposium
November 9-12 (San Diego, CA)
For further information, contact:
IEEE
445 Hoes Lane
Piscataway, NJ 08855-1331
Internet: www.gaasic.org

The 36th Annual International Symposium on Microelectronics and Electronic Packaging
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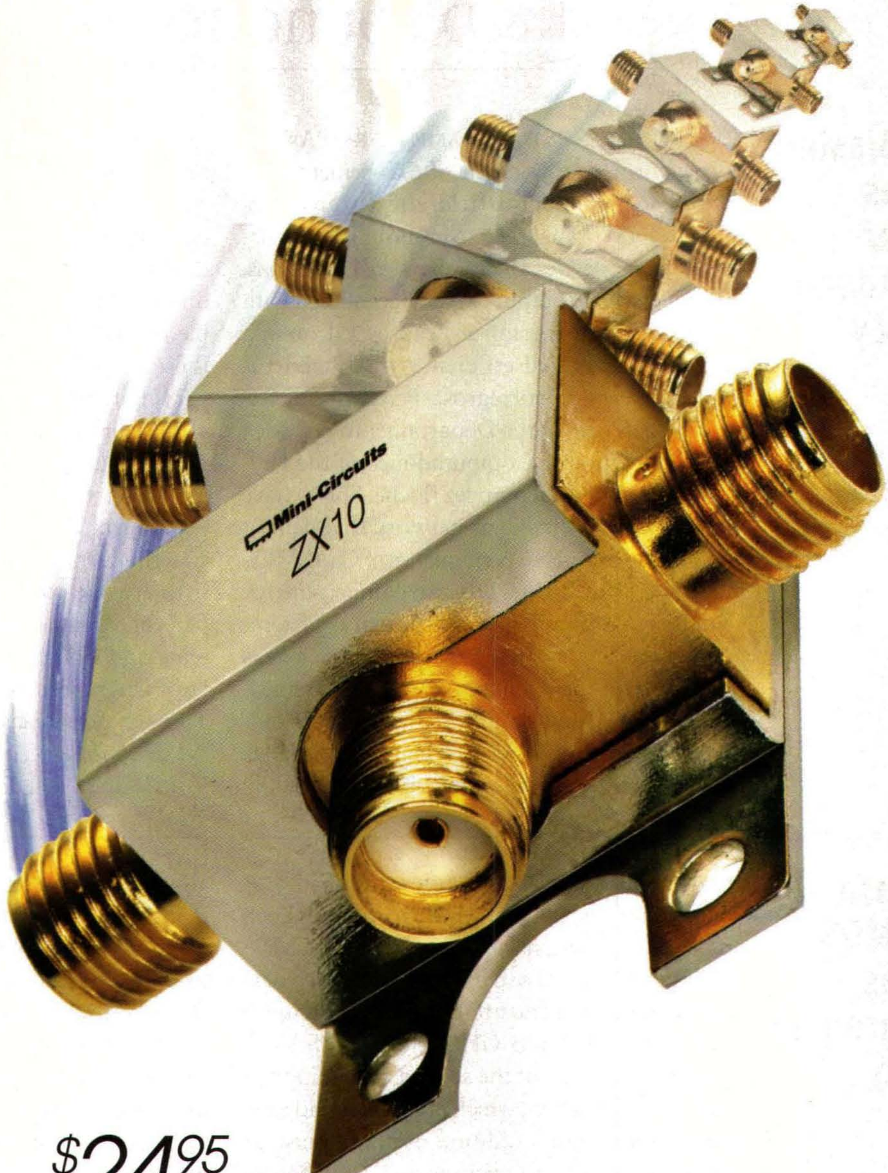

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ZX10-2-20	.2-2	20	0.8	24.95
ZX10-2-25	1-2.5	20	1.2	26.95
ZX10-2-42	1.9-4.2	23	0.2	34.95
ZX10-2-71	2.95-7.1	23	0.25	34.95
ZX10-2-98	4.75-9.8	23	0.3	39.95
ZX10-2-126	7.4-12.6	23	0.3	39.95

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Active Biasing Improves Amplifier Power-Added Efficiency

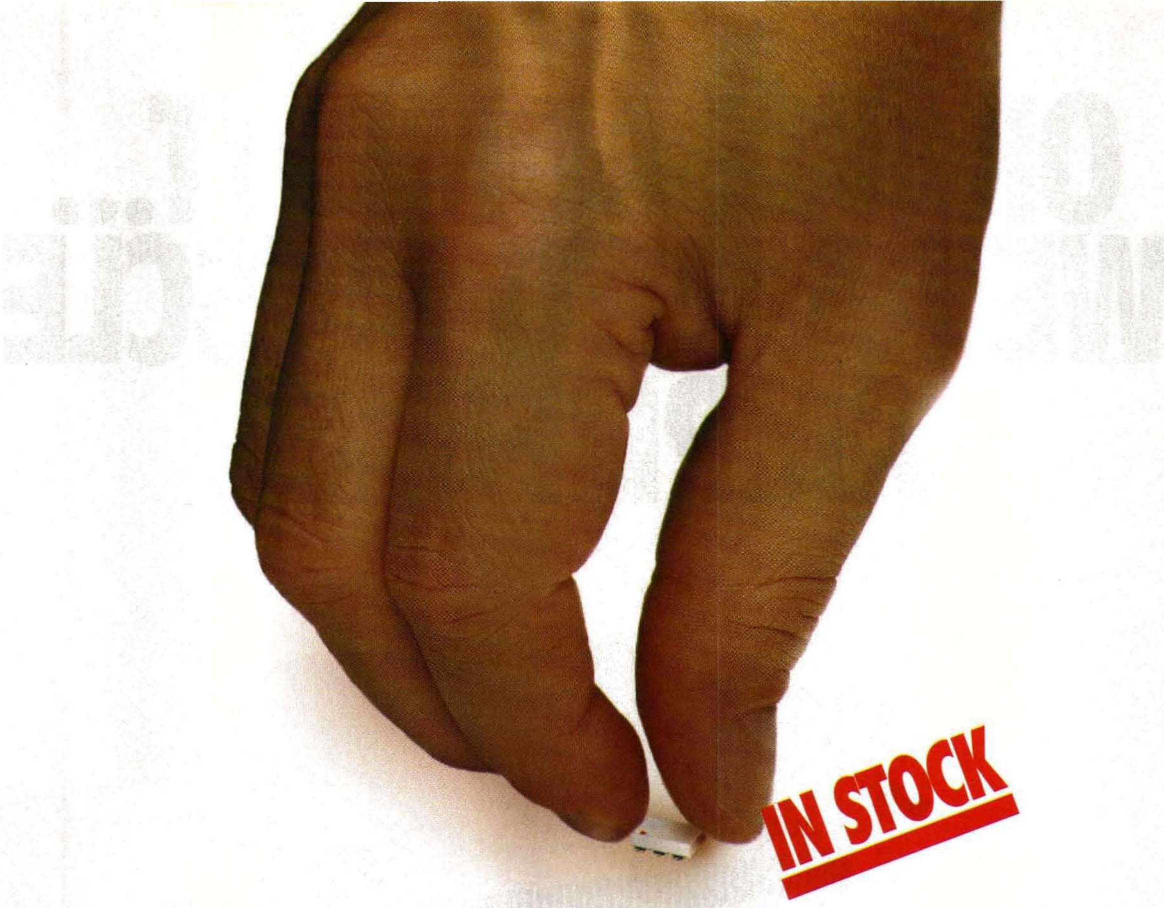
HIGH-FREQUENCY POWER AMPLIFIERS (PAs) are often formed by a chain of GaAs metal-epitaxial semiconductor field-effect transistors (MESFETs) or high-electron-mobility-transistor (HEMT) devices. Under large-signal conditions, the reverse gate output current (combined with internal device resistances) causes a drop in a PA's power-added efficiency (PAE). Fortunately, German Torregrosa-Penalva and fellow researchers at the Departamento de Fisica y Arquitectura de Computadones of the Universidad Miguel Hernandez (Elche, Spain) have developed an active bias network that cannot only improve the PAE performance of GaAs MESFET and HEMT PAs, but also compensate for small-signal gain drift as a function of temperature. The active-biasing approach was applied to GaAs monolithic-microwave-integrated-circuit (MMIC) amplifiers operating at millimeter-wave frequencies. When the active bias network is used, the network automatically sets a new external gate voltage when gate currents appear under large-signal conditions. As a result, the internal gate voltage and the drain current remain constant. The DC bias point does not change, even under large-signal conditions, and higher PAE performance is possible. In addition, when the active bias network is used, the drain current is held constant under varying temperatures. In a comparison (actual measurements) of the active bias network with resistive divider bias networks, using two millimeter-wave MMIC amplifiers as part of the experiment, the active network delivered about two times the PAE value attained by the passive network, without degradation of the amplifier's linearity performance. See "PAE Improvement and Compensation of Small-Signal Gain Drift Due to Temperature on Power Amplifiers Through Active Biasing," *Microwave and Optical Technology Letters,* September 5, 2003, Vol. 38, No. 5, p. 389.

Low-Phase Noise CMOS VCO Uses Superharmonic Coupling

NOVEL DESIGN CONCEPTS often result in dramatic improvements in RF performance. Such is the case with an inductive-capacitive (LC) CMOS voltage-controlled oscillator which uses a new concept for quadrature coupling to achieve low phase noise at 5 GHz. The CMOS VCO employs coupling of the second-harmonic signals for stabilization, which provides broadband operation without addition of phase noise or increase in power consumption. The design approach yields phase noise of better than –124 dBc/Hz offset 1 MHz from the carrier over the entire tuning range. The worst-case image rejection is 33 dB. The CMOS circuit draws just 8.75 mA from a +2.5-VDC supply. Designed nominally for IEEE 802.11a 5-GHz wireless-local-area-network (WLAN) systems, the concept of superharmonic quadrature coupling allows two differential oscillators to oscillate in quadrature by allowing a couplng network to enforce an antiphase relationship between the second-order harmonics. In developing a functional source, Sander L.J. Gierkink and co-workers from the Communications Circuit Research Department of Agere Systems (Allentown, PA) created a quadrature oscillator consisting of two separate differential oscillators whose common-mode second harmonics are coupled by means of a pair of inductors. The design was realized in a quarter-micron CMOS process, and delivered worst-case phase noise of –71 dBc/Hz offset 10 kHz from the carrier. See "A Low-Phase-Noise 5-GHz CMOS Quadrature VCO Using Superharmonic Coupling," *The IEEE Journal of Solid-State Circuits*, July 2003, Vol. 38, No. 7, p. 1148.

Compact Coplanar Amplifier Yields 4 W Power At X-Band

SOLID-STATE POWER AMPLIFIERS continue to gain ground on the domain once held exclusively by vacuum-electronics devices. Alexandre Bessemoulin from United Monolithic Semiconductors (Orsay, France) and associates from the Fraunhofer Institute for Applied Solid-State Physics (Freiburg, Germany) have developed a compact coplanar GaAs MMIC amplifier capable of 4-W output power at 1-dB compression at 10 GHz, with 18 dB gain and generous (25 percent) power-added efficiency. Based on pseudomorphic HEMT (PHEMT) device technology, the two-stage, 4 × 4-mm amplifier was fabricated on a 4-in. wafer and tested on wafer under rigorous conditions from 9.0 to 11.5 GHz. In addition, the amplifier achieved better than 40 dB reverse isolation, with PAE as high as 50 percent under saturated output-power conditions. See "A 4-W X-Band Compact Coplanar High-Power Amplifier MMIC With 18-dB Gain and 25% PAE," *The IEEE Journal of Solid-State Circuits*, September 2003, Vol. 38, No. 9, p. 1433. MRF



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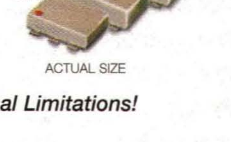

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ADE* TYPICAL SPECIFICATIONS:

MODEL	LO Power (dBm)	Freq. (MHz)	Conv. Loss Midband (dB)	L-R Isol. Midband (dB)	IP3 @Midband (dBm)	Height (mm)	Price ($ea.) Qty. 10-49
ADE-1L	+3	2-500	5.2	55	16	3	3.95
ADE-3L	+3	0.2-400	5.3	47	10	4	4.25
ADEX-10L	+4	10-1000	7.2	60	16	3	2.95
ADE-1	+7	0.5-500	5.0	55	15	4	1.99▲
ADE-1ASK	+7	2-600	5.3	50	16	3	3.95
ADE-2	+7	5-1000	6.67	47	20	3	1.99▲
ADE-2ASK	+7	1-1000	5.4	45	12	3	4.25
ADE-6	+7	0.05-250	4.6	40	10	5	4.95
ADEX-10	+7	10-1000	6.8	60	16	3	2.95
ADE-12	+7	50-1000	7.0	35	17	2	2.95
ADE-4	+7	200-1000	6.8	53	15	3	4.25
ADE-14	+7	800-1000	7.4	32	17	2	3.25
ADE-901	+7	800-1000	5.9	32	13	3	2.95
ADE-5	+7	5-1500	6.6	40	15	3	3.45
ADE-5X	+7	5-1500	6.2	33	8	3	2.95
ADE-13	+7	50-1600	8.1	40	11	2	3.10
ADE-11X	+7	10-2000	7.1	36	9	3	1.99▲
ADE-20	+7	1500-2000	5.4	31	14	3	4.95
ADE-18	+7	1700-2500	4.9	27	10	3	3.45
ADE-3GL	+7	2100-2600	6.0	34	17	2	4.95
ADE-3G	+7	2300-2700	5.6	36	13	3	3.45
ADE-28	+7	1500-2800	5.1	30	8	3	5.95
ADE-30	+7	200-3000	4.5	35	14	3	6.95
ADE-32	+7	2500-3200	5.4	29	15	3	6.95
ADE-35	+7	1600-3500	6.3	25	11	3	4.95
ADE-18W	+7	1750-3500	5.4	33	11	3	3.95
ADE-30W	+7	300-4000	6.8	35	12	3	8.95
ADE-1LH	+10	0.5-500	5.0	55	15	4	2.99
ADE-1LHW	+10	2-750	5.3	52	15	3	4.95
ADE-1MH	+13	2-500	5.2	50	17	3	5.95
ADE-1MHW	+13	0.5-600	5.2	53	17	4	6.45
ADE-10MH	+13	800-1000	7.0	34	26	4	6.95
ADE-12MH	+13	10-1200	6.3	45	22	3	6.45
ADE-25MH	+13	5-2500	6.9	34	18	3	6.95
ADE-35MH	+13	5-3500	6.9	33	18	3	9.95
ADE-42MH	+13	5-4200	7.5	29	17	3	14.95
ADE-1H	+17	0.5-500	5.3	52	23	4	4.95
ADE-1HW	+17	5-750	6.0	48	26	3	6.45
ADEX-10H	+17	10-1000	7.0	55	22	3	3.45
ADE-10H	+17	400-1000	7.0	39	30	3	7.95
ADE-12H	+17	500-1200	6.7	34	28	3	8.95
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ELECTRICAL SPECIFICATIONS

PARAMETER	MIN	TYP	MAX	UNIT	NOTES
Frequency	1.2		1.4	GHz	
Small Signal Gain	53	55	58	dB	
VSWR In/Out			1:2/1		In 50 ohm
RF Out, P1DB Comp.		+63	63.3	dBm	
Harmonics Out II, III	50	55		dBc	
Gain Tracking	-0.3	0.2	+0.3	dB	Unit-to-unit
Phase Tracking between amplifiers	-1.0	±-0.5	+1.0	degree	Unit-to-unit
VSWR Withstand Under Full Power			∞:1		All phases
Efficiency		30			
Duty			10	%	
Pulse Width	0.001		1.0	Msec	
Pulse Droop	0.0	0.02	0.1	db	

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Smart Synthesizers Simplify RF Integration

These compact narrowband and broadband frequency synthesizers can be reconfigured in frequency and step size using simple programming and standard interfaces.

System designers stress the need for higher levels of integration in RF function blocks. Such modules provide simple digital and RF interfaces and, thus, speed the time to market and simplify system-level integration and production. Unfortunately, the RF/microwave signal sources currently available do not provide a satisfactory solution that addresses these needs. Fortunately, a line of Plug-N-Play frequency synthesizers offers a practical solution, providing a high-performance synthesized source that features quick deployment.

DAVID LYLE
President/CTO
Universal Microwave Corp., 2339 Destiny Way, Odessa, FL 33556; (877) 375-9332, FAX: (727) 376-7271, Internet: www.vco1.com.

Currently, there are two synthesized source approaches that include (1) the integrated circuit (IC) that incorporates a phase-locked loop (PLL) and an onboard voltage-controlled oscillator (VCO) and (2) the VCO module with PLL circuitry added internally. In the first approach, the integrated VCO comes with a compromise in performance, compared to discrete, lumped-element VCO designs. In addition, most of these single-chip synthesizers require additional external circuitry, such as an external tank or loop filter. Such sources can also require significant effort in writing control software.

When discrete VCOs are integrated with the best of PLL chips and supplied in module form, the system designer is still faced with a number of problems. First, each new application calls for a custom design. Each new requirement has an impact on the frequency range, step size, reference frequency, and loop bandwidth. Once these have been established, the signal-source designer must create a unique product to fit these criteria where even the subtlest change can affect circuit values or even design topology. Additionally, the system designer is still left with the task of understanding the inner workings of the entire module prior to integration, so that control software can be developed. The risk of designing with this solution is much higher since changes during the design phase (frequency plan, step size, etc.) can be costly and time-consuming. Also, the lack of stan-

FUNCTION SELECT (4 BITS)				MULTIPLIER (4 BITS)				FREQUENCY/CHANNEL (24 BITS)					
DB31	DB30	DB29	DB28	DB27	DB26	DB25	DB24	DB23	DB22	DB_n	DB2	DB1	DB0
FS3	FS2	FS1	FS0	M3	M2	M1	M0	FC23	FC22	FC_n	FC2	FC1	FC0

1. PNP frequency synthesizers typically require only 32-b command words to execute changes in frequency and step size, with 40-b data used to chance settings on an I²C bus.

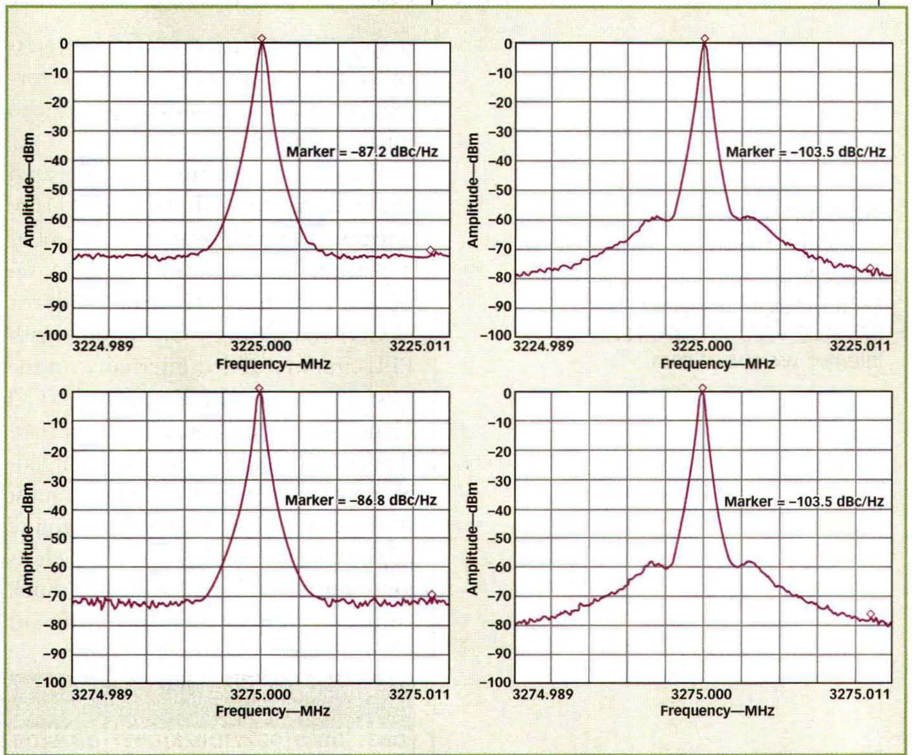
Table 1: Reviewing factory presets

ATTRIBUTE	FUNCTION SELECT	MULTIPLIER	FREQUENCY/ CHANNEL	RESULT
START frequency	01	8	32	3200 MHz
STOP frequency	02	8	33	3300 MHz
STEP size	03	6	1	1 MHz
REF frequency	04	7	1	10 MHz
CHANNEL number	00	0	0	3200.00 MHz
CHANNEL number	00	0	1	3201.00 MHz
CHANNEL number	0	0	2	3202.00 MHz
CHANNEL number	0	0	3	3203.00 MHz
CHANNEL number	0	0	100	3300.00 MHz

dardization in package size and interfaces leaves system designers with precious new options.

Because of the problems posed by these two synthesizer "solutions," the engineers at Universal Microwave Corp. (Odessa, FL) have developed the Plug-N-Play family (PNP series) of frequency synthesizers. These are truly configurable modules, which take mere minutes, rather than weeks, to deploy. They are designed to simplify integration for both RF designers and system software developers. The frequency synthesizers are supplied in compact surface-mount packages for ease of integration in even the smallest system designs.

These compact sources offer a host of improvements compared to traditional VCO/PLL combinations. Both I^2C bus and SPI bus designers will find the PNP series straightforward with a digital interface shared by the most popular modern protocols. Code writers will find the simplicity of developing software for functional control. Any number of PNP devices can reside on the same bus, and while these modules are always on-line waiting to receive data, their internal architecture provides inherent isolation between the



2. The phase noise of the PNP-3250-L22 frequency synthesizer remains low when measured close to the carrier (top left) and far from the carrier (top right) with large step sizes or close to the carrier (bottom left) or further from the carrier (bottom right) with smaller step sizes.

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digital bus and the RF output.

The PNP synthesizers are extremely flexible, giving the designer the ability to configure all of the synthesizer's vital functions "on the fly," using simple strings of code that comprise the Configuration Data.

These initialization blocks of code contain commands for start frequency (START), stop frequency (STOP), frequency step size (STEP), and reference frequency (REF). Once these four variables are set, a finite number of channels are created and entering a new frequency is accomplished by updating the CHANNEL register. By delivering these simple words over the bus, the PNP architecture recognizes its new role and resets the loop to accommodate its new setup. The PNP module optimizes its internal settings for best overall integrated phase noise, switching speed, and spurious suppression, all automatically and in less than 100 μs. For example, if the system requires 100-kHz steps in one mode and 1-MHz steps in another mode, a PNP synthesizer can make the adjustments instantly without compromises in accuracy, speed, or performance.

The PNP synthesizers offer ease of integration for both RF and software engineers. The signal sources can be deployed in virtually any system without the complexity of code writing typically associated with frequency-synthesizer modules. The PNP family of intelligent frequency synthesizers can be controlled through the use of a microprocessor interface or bus. The PNP synthesizers support several protocols, such as SPI bus, Microwire interfaces, and I^2C bus implementations. For SPI and Microwire applications, PNP devices require a single 32-b string of serial data to set frequency or to change internal settings **(Fig. 1)**. The I^2C bus utilizes some unique control bits and requires the addition of an Address byte, increasing the serial bit stream for this protocol to 40 b per command.

Each PNP synthesizer is programmed at the factory with presets for all of the registers. If these factory values are acceptable, there is no reason to reload

any of these registers. If an application requires values other than the factory presets, the PNP synthesizer must first be initialized by loading data into each of the affected FUNCTION registers. These might include START, STOP, STEP, or REFERENCE. It is not necessary to re-load any registers that are already set properly for the application. START defines the lowest desired frequency of operation. STOP defines the highest desired frequency of operation. STEP is used to channelize the band, and REFERENCE defines the frequency of the external reference. Once the PNP synthesizer is initialized, a fixed number of channels are available. Loading the CHANNEL register sets the operating frequency of the PNP device. The formula for calculating the operating frequency is simply: START (in Hz) + [CHANNEL × STEP (in Hz)] = Frequency (Hz).

Every PNP synthesizer is loaded with factory default settings so that when a module is powered up, it has a valid operating state. It then monitors the bus for instructions as to its new configuration. As an example, the model PNP-3250-L22 synthesizer has an available range of 3200 to 3300 MHz. With its factory presets, the unit will tune over the full operating band of 3200 to 3300 MHz in 1 MHz when operating with a 10-MHz external reference oscillator **(Table 1)**.

When the step size is changed, the spurious and phase-noise performance of the PNP-3250-L22 synthesizer does not suffer, indicating that the loop in the PNP source has been reoptimized for best overall performance. When adjusting for smaller steps, the microprocessor first sends new settings to the PNP synthesizer. The only register affected by this new setup is the STEP

Table 2: A sampling of synthesizers

MODEL NUMBER	MINIMUM FREQUENCY (MHz)	MAXIMUM FREQUENCY (MHz)	MINIMUM FREQUENCY (MHz)	MAXIMUM STEP (kHz)	LOOP BW (kHz) TYP	OUTPUT POWER (dBm) TYP.	PHASE NOISE, 1-kHz OFFSET (dBc/Hz)	PHASE NOISE, 10-kHz OFFSET (dBc/Hz)
PNP-850-L22	800	900	25	10000	2.8	0	-95	-108
PNP-3250-L22	3200	3300	25	10000	2.8	0	-85	-103
PNP-3950-L22	3900	4000	25	10000	2.8	0	-80	-100
PNP-1028-N22	55	2000	25	10000	2.8	0	-85	-100
PNP-1500-P22	1000	2000	25	10000	2.8	0	-82	-100


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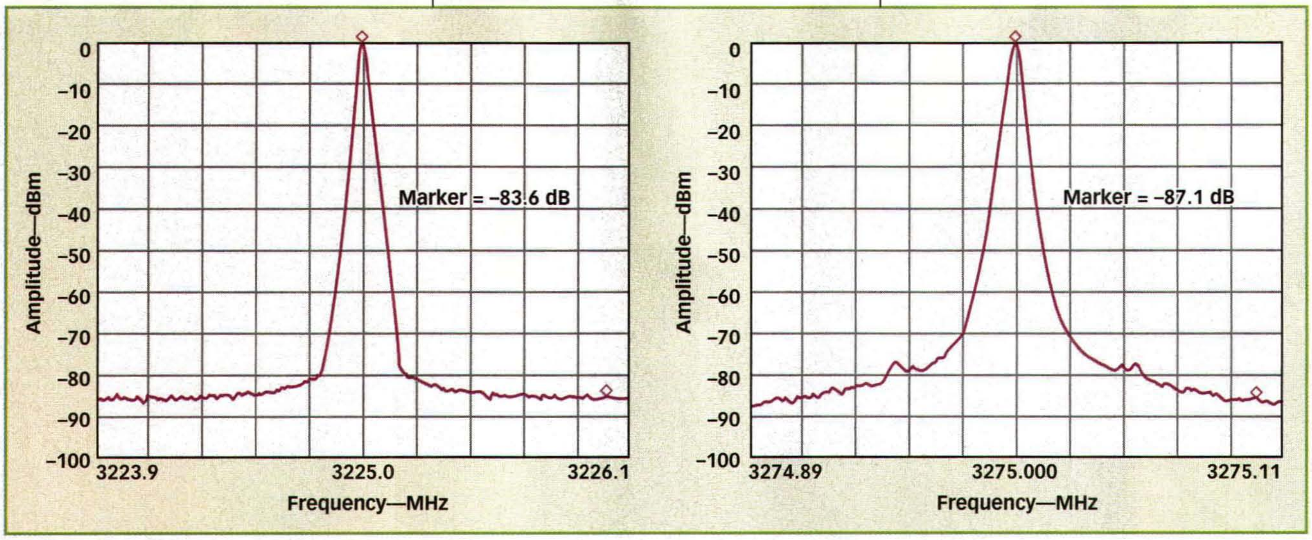
register. As a result, a user need only send a single string of data to accomplish a move from 1-MHz steps to 100-kHz steps. However, the number of available channels increases accordingly.

The PNP frequency synthesizers can handle virtually any step size from 5 kHz to 10 MHz without degradation in phase noise. While spurious performance will obviously change with very small steps, the PNP series was designed with the goal of maintaining outstanding phase-noise performance regardless of step size. In the previous example, the PNP-3250-L22 is set for 1-MHz steps (factory default settings) and then reprogrammed to take 100-kHz steps. In spite of the change, the phase-noise



3. The spurious performance of the PNP-3250-L22 frequency synthesizer remains consistent with different step sizes.

performance remains consistent no matter what step size is used **(Fig. 2)**. Similarly, spurious contributions are also well controlled and consistent with changes in step size **(Fig. 3)**.

Another example of the PNP line, the PNP-1500-P22, is designed for full-octave coverage from 1000 to 2000 MHz **(Fig. 4)**. It achieves such wideband coverage without the use of high supply voltages typically associated with wideband frequency synthesizers. The PNP-1500-P22 is powered by supplies of +3 VDC (digital circuitry) and +12.5 VDC (analog circuitry). The compact source measures just $0.60 \times 0.60 \times 0.220$ in. ($1.5 \times 1.5 \times 0.56$ cm) and includes the VCO, buffer amplifier, PLL, loop filter, and PNP interface within the package.

The PNP synthesizers are currently available in over 40 bands covering the frequency range from 50 MHz to 5.5 GHz **(Table 2)**. Narrowband designs employ +3-VDC supplies for the digital circuitry and +5-VDC supplies for the analog circuitry. Wideband models are powered by +3 VDC for the digital circuitry and +12.5 VDC for the analog circuitry.

In addition to the units shown in the table, model PNP-950-L22 operates from 900 to 1000 MHz, model PNP-1250-L22 operates from 1200 to 1300 MHz, model PNP-1350-L22 runs 1300 to 1400 MHz, and model PNP-1450-L22 runs from 1400 to 1500 MHz. All these frequency synthesizers provide programmable frequency step sizes from 25 to 10,000 kHz with typical output power of 0 dBm. The phase noise for the PNP-950-L22 is typically –110 dBc/Hz offset 10 kHz from the carrier. The phase noise for the PNP-1250-L22 and PNP-1350-L22 synthesizers is –108 dBc/Hz offset 10 kHz from the carrier, and the phase noise for the PNP-1450-L22 is –107 dBc/Hz offset 10 kHz from the carrier.

The PNP-525-N22 frequency synthesizer is an example of a unit with similar frequency coverage but at much lower carrier frequencies. The PNP-525-N22 is designed for use from 50 to 1000 MHz and also can be programmed to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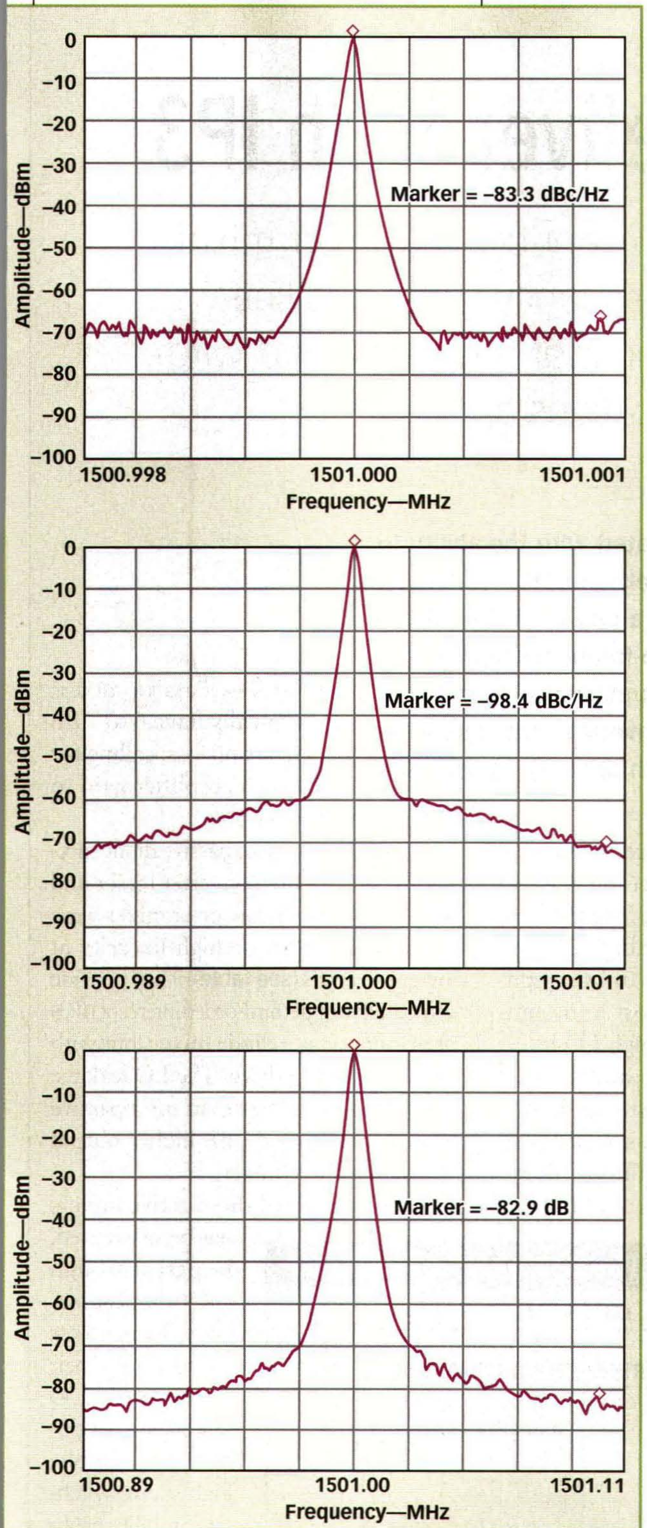
tune in frequency steps from 25 to 10,000 kHz. While the earlier-described synthesizers are built for +5-VDC power supplies, the PNP-525-N22 operates on a +15-VDC supply (with typical current draw of 35 mA). The PNP-525-N22 achieves typical output power of 0 dBm across its full frequency range, with typical phase noise of −105 dBc/Hz offset 10 kHz from the carrier.

The compact synthesizer modules measure only 0.5 × 0.5 × 0.180 in. (1.27 × 1.27 × 0.46 cm). Any model can be preprogrammed at the factory for operation as a phase-locked oscillator (PLO) when a digital interface is not available or required. By loading a PNP source with a preset frequency of operation, a unit can be supplied for operation at any fixed frequency from 50 MHz to over 5 GHz, with only a power supply and external reference source needed for operation. The miniature synthesizers are well suited for a wide range of applications, including as precision sources in test instruments, as local oscillators (LOs) in digital microwave radios, or as compact building-block frequency sources for larger commercial or military frequency-synthesizer systems. For additional information on the programmable frequency synthesizers, please visit the company's website at www.vco1.com (specifications and outline drawings are available for more than 30 different representative models, with custom units also available). MRF



4. The PNP-1500-P2 frequency synthesizer features good phase noise when measured close to the carrier (top) or further from the carrier (middle), as well as extremely low spurious noise (bottom).

Active Mixers Deliver High IP3

A pair of active double-balanced mixers provides the frequency range and linearity needed for a host of broadcast and wireless communications applications.

Active mixers have long been associated with the ability to work at low local-oscillator (LO) levels, but falling short on linearity performance. Fortunately, a pair of active mixers has been developed based on a high-frequency bipolar process from Linear Technology. These plastic-packaged mixers are suitable for frequency upconversion and downconversion functions, respectively, with linearity comparable to passive diode mixers.

TOM SCHILTZ
Senior RF IC Design Engineer
BILL BECKWITH
Senior RF IC Design Engineer
Linear Technology Corp., Colorado Design Center, 950 Chapel Hills Dr., Colorado Springs, CO 80920-3984; (719) 593-1579, FAX: (719) 598-0977, Internet: www.linear.com.

Passive diode mixers are widely used in wireless and cable-television (CATV) infrastructure equipment for their high linearity. Their need for high LO signals requires the addition of LO amplifiers, which also add cost and compromise isolation. The high LO levels can lead to signal leakage, and the need for additional filtering. Passive diode mixers also suffer from high sensitivity to the LO-signal input amplitude, therefore requiring tight control of LO signal flatness. Passive mixers also typically have 6 to 7 dB of conversion loss, calling for additional amplifier gain to compensate for the loss.

As an alternative to passive diode mixers, the LT5511 upconverter mixer and the LT5512 downconverter mixer were developed to provide high linearity at lower LO levels **(see table)**. They provide comparable input third-order-intercept (IP3) performance as a diode mixer, but with 20 dB lower LO drive. The LO leakage is about 20 dB better than for a passive mixer, with about 7 dB higher output IP3 than a diode mixer.

The linearity of these active mixers has been achieved, in part, through careful optimization of the mixer core designs. Their integrated LO amplifiers are optimized for stable, high-speed switching. Stability problems common to other designs often require the addition of ferrite

The LT5511 and LT5512 mixers at a glance

RF = 950 MHz, LO = 1 GHz, IF = 70 MHz

	LT5511 (UPCONVERTER)	LT5512 (DOWNCONVERTER)	PASSIVE MIXER
Conversion gain (dB)	0 (IF to RF)	1 (RF to IF)	-7
Input IP3 (dBm)	+17	+21	+17
LO-RF leakage (dBm)	-46	-52	-25
LO-IF isolation (dB)	-	36	26
LO power (dBm)	-10	-10	+10

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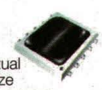

Actual Size

Typical Specifications

Model	LO Level (dBm)	Freq. (MHz)	Conv. Loss (dB)	LO-RF Isol. (dB)	Price $ ea. (Qty. 10)
MCA1-24	7	300-2400	6.1	40	5.95
MCA1-42	7	1000-4200	6.1	35	6.95
MCA1-60	7	1600-6000	6.2	30	7.95
MCA1-24LH	10	300-2400	6.5	40	6.45
MCA1-42LH	10	1000-4200	6.0	38	7.45
MCA1-60LH	10	1700-6000	6.3	30	8.45
MCA1-24MH	13	300-2400	6.1	40	6.95
MCA1-42MH	13	1000-4200	6.2	35	7.95
MCA1-60MH	13	1600-6000	6.4	27	8.95

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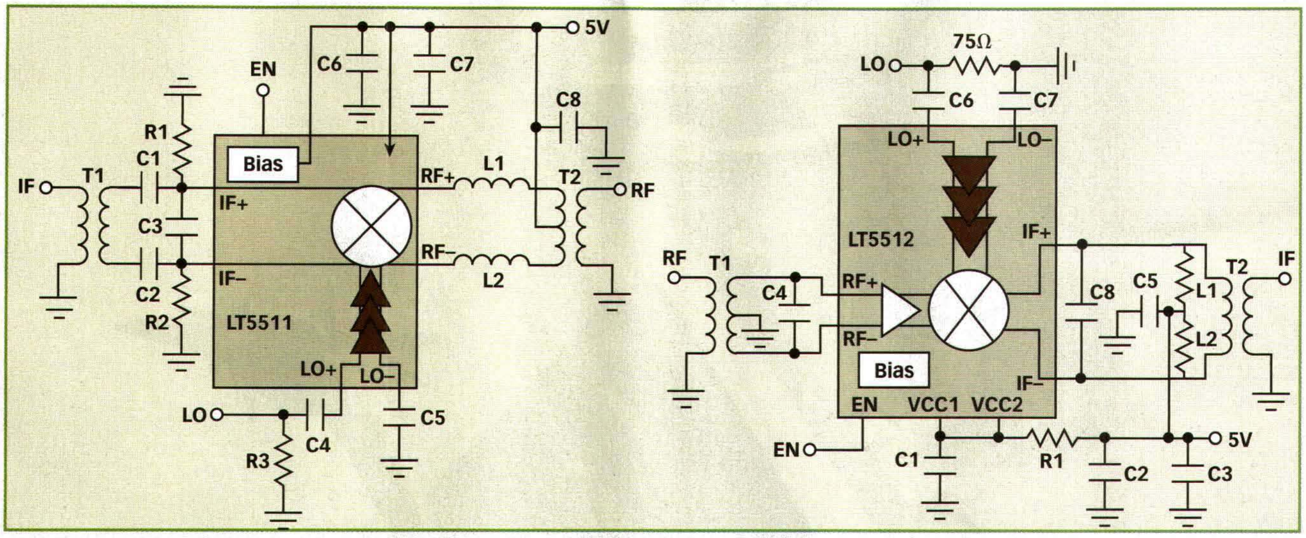
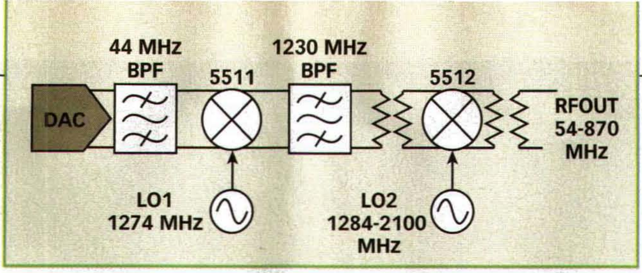


1. Diagrams for the LT5511 upconversion mixer (left) and LT5512 downconversion mixer (right) include matching elements.

beads and resistors to the application board on which the mixer is mounted. The active mixers can be driven by single-ended LO sources, even beyond 2.5 GHz. They are designed to tolerate wide variations in input LO power with negligible impact on mixer performance.

Both the LT5511 upconverter **(Fig. 1, top)** and LT5512 downconverter **(Fig. 1, bottom)** mixers use an optimized double-balanced mixer core with the transistors' bases driven by an integrated LO buffer amplifier. Precision integrated bias circuits ensure high performance over temperature; both ICs provide an enable control input for a power-down function. The mixers have differential RF, LO, and intermediate-frequency (IF) ports that allow flexibility of impedance matching for use in a wide variety of applications. Careful die lay-



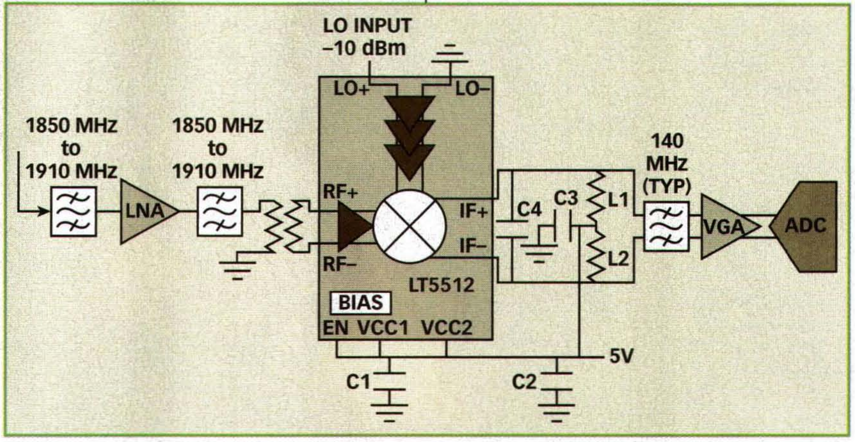
2. The upconversion and downconversion mixers enable this downlink transmitter circuit for CATV systems.

out and well-planned package pinouts yield good port-to-port isolation and linearity. The LT5511 is packaged in a 16-lead TSSOP while the LT5512 is supplied in a 16-lead, 4 × 4-mm QFN housing.

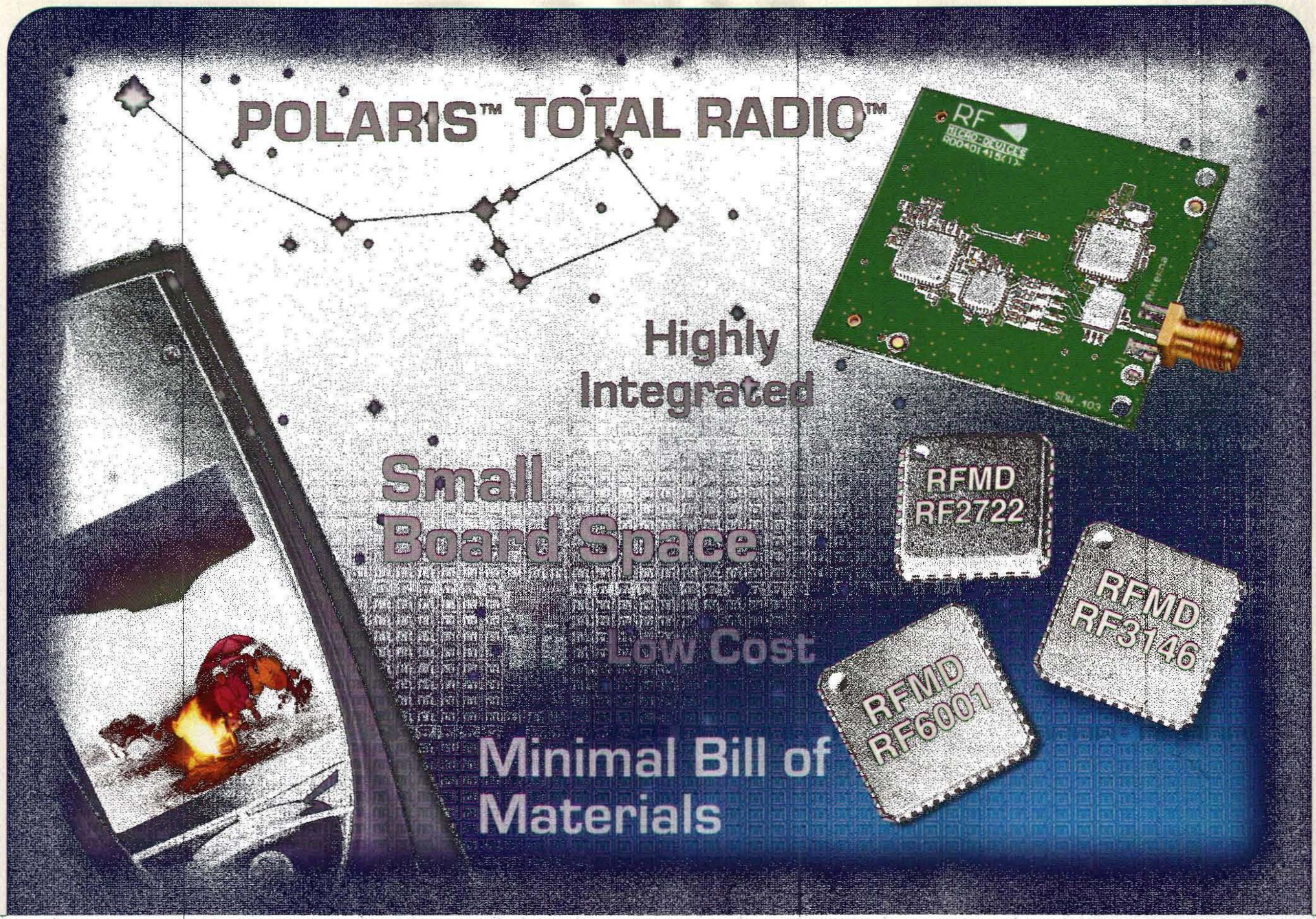
The LT5511's IF input is simple to match. Two resistors set the current through the mixer core, while two DC blocks (for symmetry) provide DC isolation between the IF+ and IF- input ports. A capacitor across the IF ports reduces LO leakage. An IF balun performs an impedance transformation and single-ended-to-differential conversion. With a differential signal source, such as a digital-to-analog converter (DAC), it may be possible to eliminate the input balun.

The RF output match is realized with a pair of inductors, or transmission lines, followed by a balun. The match can be optimized with a shunt capacitor at the output. The LO port is matched with a shunt 62-Ω resistor and a DC blocking capacitor for frequencies below 1.5 GHz. At higher LO frequencies, the match requires only a shunt-series inductor-capacitor (LC) combination.

The LT5512's RF input port is easily matched for applications between 10 MHz and 3 GHz. RF match-



3. This multichannel wireless infrastructure receiver is based on the use of the LT5512 downconverter mixer to translate PCS frequencies to a 140-MHz IF.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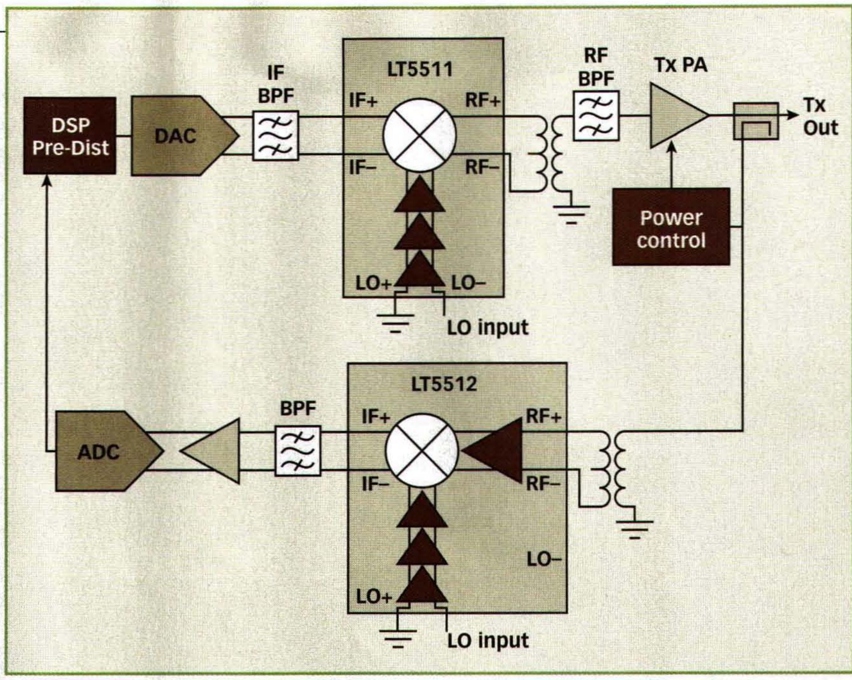
ing consists of one capacitor and a balun for single-ended-to-differential conversion. The center tap on the RF balun also provides a DC return path for the RF buffer amplifier. The IF output is also simple to match, requiring two bias chokes and a capacitor to set the output IF. An IF balun may be used for differential-to-single-ended conversion. The LO port is matched with a shunt resistor and DC blocking caps. A balun is not required for the LO port.

The active mixers are well suited for use in a CATV downlink transmitter for analog and digital television. In a simplified block diagram for this application **(Fig. 2)**, variable attenuators required for precise output power control are not shown. In this architecture, a 44-MHz input signal from the DAC is filtered and upconverted to 1230 MHz by the LT5511 using a fixed LO. A bandpass filter attenuates the image frequency and any unwanted spurious. The resulting signal then drives the RF input of the LT5512. A wideband LO feeds the LT5512 to downconvert the 1230-MHz IF to the desired output frequency in the 54-to-870-MHz band. In this application, all spurious products within the CATV band must be 60 dB below the desired signal level.

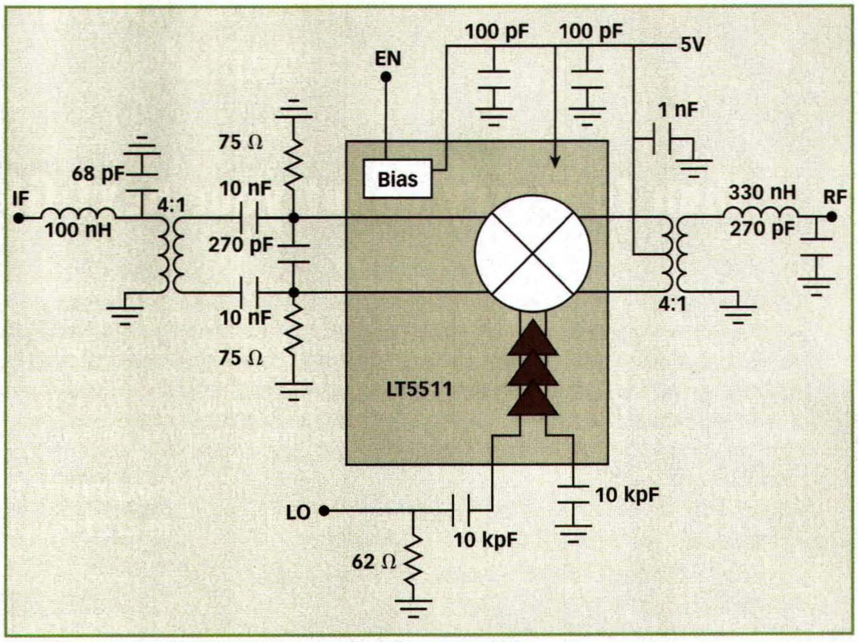
The good linearity of these active mixers also makes them well suited for low-distortion cellular applications, including multichannel receivers **(Fig. 3)**. In this receiver, the LT5512 downconverts PCS input signals to a 140-MHz IF. The mixer's differential IF output is matched directly to a differential SAW filter, eliminating the need for an IF balun while preserving the benefits of differential signal processing to the ADC.

On the multiple-carrier transmit side, the LT5511 can be used to upconvert multiple carriers from a DAC directly to the transmit frequency **(Fig. 4)**. The LT5512 is then used in a pre-distortion feedback loop to downconvert a sample of the transmit signal for digital processing.

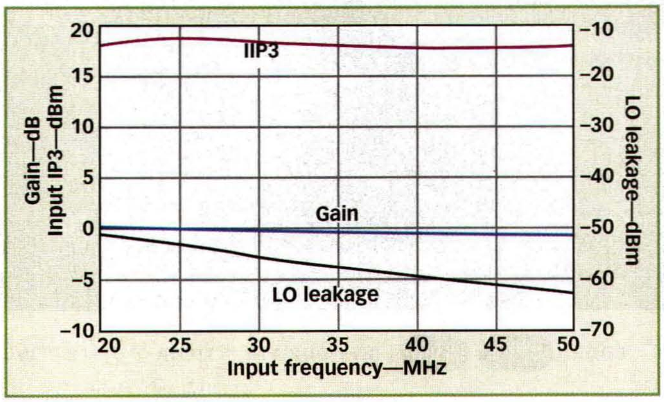
To demonstrate its versatility, the LT5511 was evaluated in a low-frequency downmixer application requiring high linearity **(Fig. 5)**. In this case, the mixer had an input frequency range



4. This multichannel wireless infrastructure transmitter features predistortion feedback.



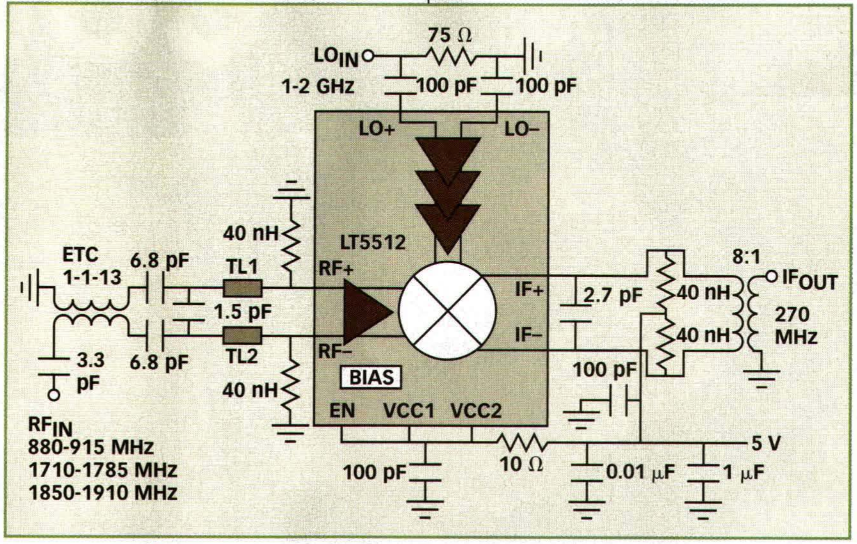
5. With the proper impedance matching components, the LT5511 upconversion mixer can be used at HF.



6. The measured performance of the LT5511 shows that it is fully capable of handling low-frequency applications with the proper external impedance matching.

of 20 to 50 MHz and an output frequency of 10 MHz. On the IF input, the values of the components have been increased to accommodate the lower frequencies and a series-shunt LC combination prior to the transformer was added to optimize the impedance match. The output match is very simple, requiring only the balun, a series inductor, and shunt capacitor. On the LO port, a larger DC blocking capacitor was used for the lower-frequency coverage. At an IF of 25 MHz and an LO level of –10 dBm, conversion gain was 0 dB, input IP3 was +18.8 dBm, and LO leakage to the output was –41 dBm **(Fig. 6)**. The measured input second-order intercept (IP2) performance was +61 dBm.

Another example of the flexibility of these mixers is a triband downconversion application for the LT5512 in which a bandpass RF input matching network supports operation at the 900, 1800, and 1900 MHz GSM bands **(Fig. 7)**. The IF port is matched for 270-MHz operation. The design achieves 0.7 dB conversion gain at 900 MHz with 0.3 dB conversion gain at 1800 MHz and only 0.2 dB conversion loss at 1900 MHz. The input IP3 levels at 900, 1800, and 1900 MHz, respectively, are +18.3, +18.2, and +20.6 dBm. MRF



7. This application circuit uses the active mixers to handle downconversion for the 900-, 1800-, and 1900-MHz GSM bands.

Measure The Gain Compression Of Power Amplifiers

ACCURATE MEASUREMENTS OF AN amplifier's 1-dB gain compression can simplify comparisons of different products. Basic test instruments required for such measurements include a high-quality RF or microwave frequency synthesizer (to supply stimulus signals) and a high-performance power meter (to evaluate the output signal levels generated by the amplifier under test). Power meters are used in a traditional measurement setup because they can be calibrated and offer high levels of accuracy over a wide measurement dynamic range.

An alternative approach to making amplifier gain-compression measurements also relies on the frequency synthesizer, but substitutes a scalar network analyzer for the power meter. The method, as outlined in the an application note from Giga-tronics, Inc. (San Ramon, CA), "Measuring Gain Compression of Power Amplifiers," can achieve the accuracy associated with a power-meter-based test system, but with considerably less measurement time. The application note is based on the company's model 12000A microwave frequency synthesizer and the model 8003 scalar network analyzer.

As the note describes, in order to verify the worst-case 1-dB compression point of an amplifier under test with a power meter, many repetitions may be necessary at different frequencies. A scalar network analyzer allows swept-frequency measurements to be made over the full operating range of the amplifier. Measurement accuracy is maintained by using a frequency synthesizer which locks and stabilizes the frequency at each point to an internal or external reference source. By setting the scalar network analyzer to display gain and output power, it is possible to determine the input power level where an amplifier's gain has decreased by 1 dB (the 1-dB compression point). Once this first 1-dB point has been located for the lowest frequency of operation for the amplifier under test, it is set as a reference point for further measurements throughout the amplifier's operating frequency range. For more information, download a free copy of the illustrated four-page application note from the company's website.

Giga-tronics, Inc., 4650 Norris Canyon Rd., San Ramon, CA 94583; (925) 328-4650, FAX: (925) 328-4700, Internet: www.gigatronics.com.

By setting the scalar network analyzer to display gain and output power, it is possible to determine the input power level where an amplifier's gain has decreased by 1 dB.

Optimizing VCO And Frequency-Synthesizer Designs

VOLTAGE-CONTROLLED OSCILLATORS (VCOS) and phase-locked loops (PLLs) are used throughout wireless communications systems as signal sources for frequency downconversion and upconversion in receivers and transmitters. Optimizing the performance of these components requires the experience and expertise of a small handful of seasoned design engineers. Fortunately, an application note from Agilent Technologies, "Agilent 4352S VCO/PLL Signal Test System: Optimizing VCO/PLL Evaluations and PLL Synthesizer Designs," provides some guidance into the fine art of VCO and PLL optimization (including the loop filters) for those engineers with even limited experience.

The application note reviews the key characteristics of VCOs, including oscillation frequency, power level, phase noise, tuning sensitivity, and harmonic/spurious noise, and also details the problems with the conventional method of evaluating VCOs and PLLs. For example, the use of a general-purpose DC power supply as the DC control voltage source for the VCO can degrade the measured VCO phase-noise characteristics and provide misleading information about the performance of the VCO under evaluation.

The solution lies in the use of the 4352S measurement system for characterizing and evaluating PLLs and VCOs. The system is self-contained, and includes its own low-noise DC power source for tuning VCOs under test. Additional instrument functions in the system include a digital multimeter, modulation source, RF power meter, frequency counter, and Fast Fourier Transform (FFT) analyzer. The system is relatively simple to operate, since its automatic frequency-control capability works with the frequency counter and DC source to precisely control DC tuning voltage based on desired operating frequencies entered by the test operator. Copies of the 24-page note, which includes extensive details on different system configurations, can be downloaded from the company's website.

Agilent Technologies, (800) 452-4844, Internet: www.agilent.com.

cover story

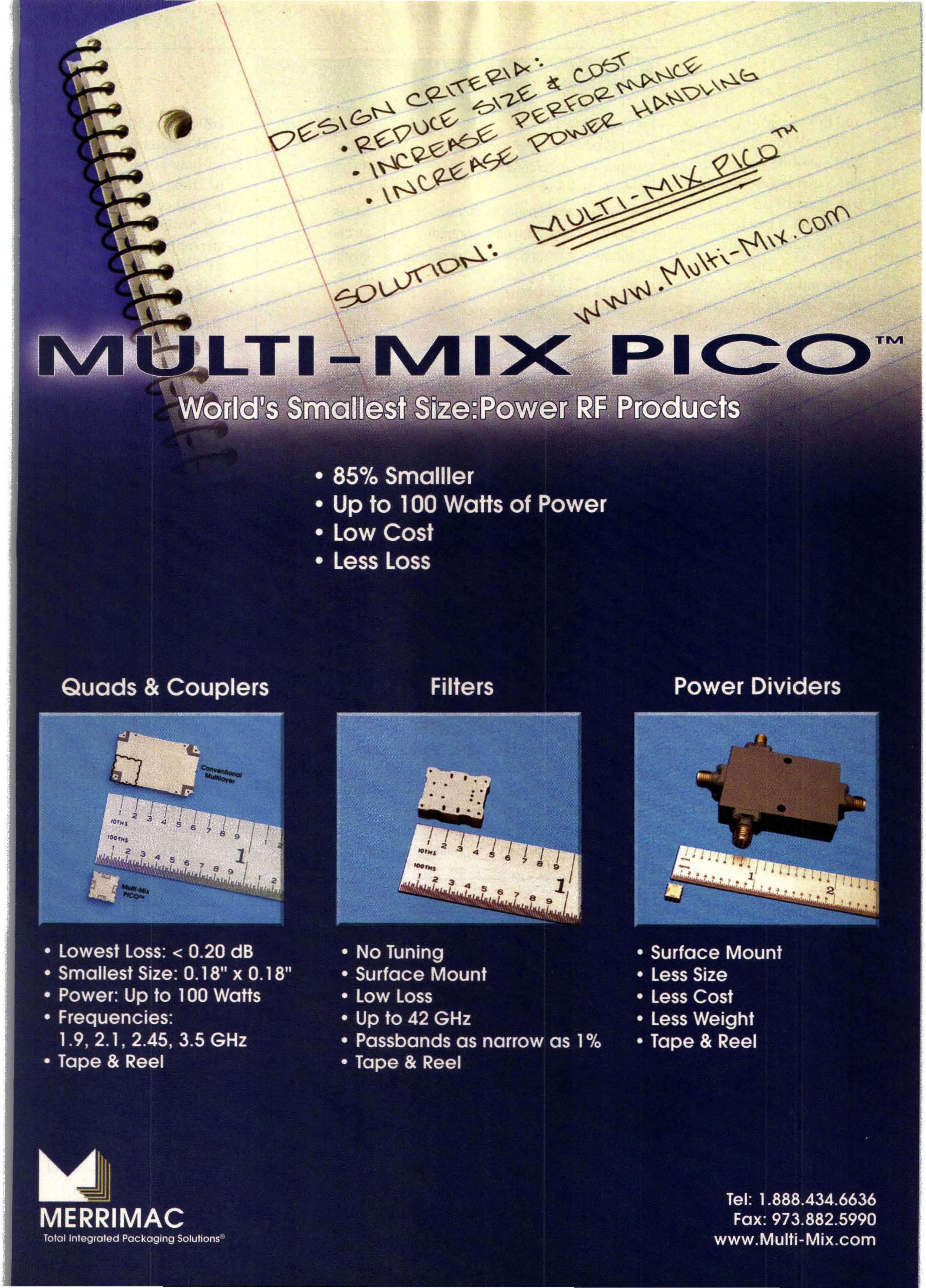
SiGe Direct Modulators Ease Upconverter Design

These efficient direct quadrature modulators support digital modulation formats with I and Q bandwidths as wide as 250 MHz for carrier frequencies from 250 to 7000 MHz.

MARK T. FALLICA
Marketing Engineer, Product Development Group
Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01824; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.

Direct quadrature modulators provide many benefits to transceiver/transmitter designers working with modern digital-modulation formats. Compared to superheterodyne upconversion approaches, direct quadrature modulation enables simpler, smaller designs at lower costs. With advances in RF integrated circuit (RF IC) and silicon-germanium (SiGe) process technologies, the engineers at Hittite Microwave have succeeded in bringing direct quadrature modulator components to a new level, extending direct modulation to 7 GHz. The company's models HMC495LP3 and HMC496LP3 SiGe direct quadrature modulators work from 250 to 3800 MHz and from 4.0 to 7.0 GHz, respectively, housed in compact 3 × 3-mm leadless surface-mount packages. With these modulators, designers can simplify a transmit-signal chain by eliminating one mixer stage, along with its associated matching, filtering, voltage-controlled oscillator (VCO), phase-locked loop (PLL),

1. The HMC495LP3 and HMC496LP3 direct quadrature modulators are supplied in compact, 3 × 3-mm leadless surface-mount packages.



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The HMC495LP3 direct modulator at a glance	
PARAMETER	**SPECIFICATION**
Frequency range	250 to 3800 MHz
Output power at 1-dB compression	0 dBm
Output third-order intercept	+13 dBm
Output noise floor	–158 dBm
Carrier suppression (uncalibrated)	–34 dBc
Sideband suppression (uncalibrated)	–28 dBc
Third-order intermodulation suppression	–50 dBc
Typical ACPR for CDMA IS-95 (at 880 and 1960 MHz)	–72 dBc
Typical ACPR for WCDMA 3GPP (at 2140 MHz)	–59 dBc

Note: Values are worst case for full band.

and LO buffering circuitry.

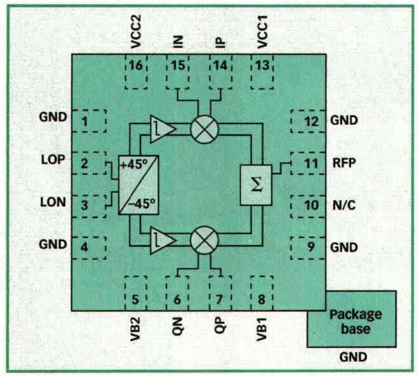
The HMC495LP3 and HMC496LP3 wideband SiGe direct quadrature modulators **(Fig. 1)** are based on high-frequency SiGe heterojunction-bipolar-transistor (HBT) technology. The silicon semiconductor process supports high-level integration at extremely high transition frequencies and with relatively low power consumption. The lower-frequency HMC495LP3 is suitable for Global System for Mobile Communications (GSM), code-division multiple access (CDMA), wideband CDMA (WCDMA), personal handyphone system (PHS), fixed-wireless, MMDS, and wireless-local-loop (WLL) systems. The higher-frequency HMC496LP3 serves IEEE 802.11a wireless-local-area-network (WLAN), UNII, and microwave radio applications.

The HMC495LP3 employs a polyphase network which separates the local oscillator (LO) into two equal amplitude signals, with 90-deg. phase difference between them **(Fig. 2)**. The signal-splitting and limiting-amplification circuitry comprising the polyphase network is designed for optimum performance over a wide range of LO input power levels. LO signal paths are closely matched on chip to minimize phase offsets; the differential-mode transmission lines provide excellent immunity to noise. Each divided LO signal drives an active Gilbert-cell mixer, upconverting the IP/IN in-phase and QP/QN quadrature baseband data inputs, respectively. The upconverted IP/IN and QP/QN signals are then recombined in-phase, and converted from a balanced transmission line to a single-ended RF output.

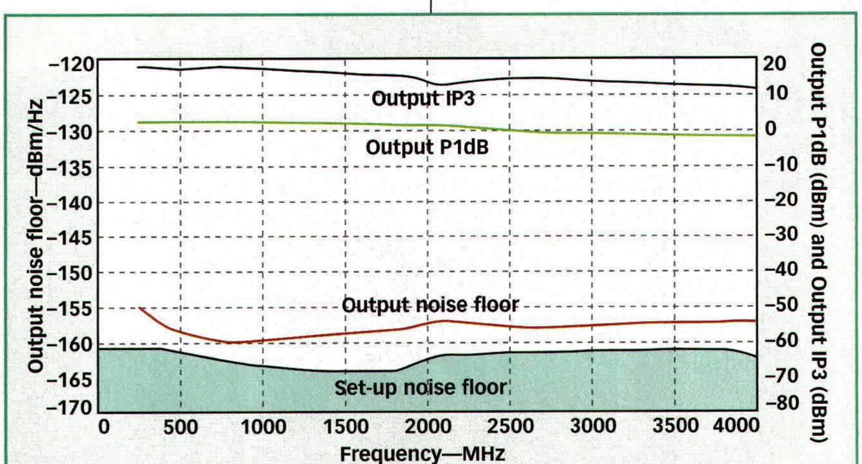
The dynamic range of a direct quadrature modulator is critical in maintaining the integrity of digitally modulated signals. The dynamic range of a direct modulator can be defined as the ratio of its output power at 1-dB compression (in dBm) to its output noise floor (in dBm/Hz). The HMC495LP3 achieves output power at 1-dB compression of typically +2 dBm at 450 MHz and –2 dBm at 3800 MHz. The device's output noise floor is typically –157 dBm/Hz at 450 MHz and at 3800 MHz **(Fig. 3)**, with the output noise floor measured at an offset of 20 MHz from the carrier, with supply voltage (V_{cc}) of +3.3 VDC and baseband bias voltage (V_{DC}) of +1.15 VDC. These values translate into a dynamic range of 155 to 159 dB across the 450-to-3800-MHz band.

Another important aspect of a direct quadrature modulator's performance is its sideband and carrier suppression, as well as its ability to control third-harmonic output levels. The HMC495LP3 direct quadrature modulator typically attains sideband and carrier suppression of –30 and –35 dBc, respectively, with output third-harmonic distortion of –50 dBc across the full band **(see table)**. These suppression levels were measured for typical output power of –6 dBm, V_{cc} of +3.3 VDC, baseband frequency of 200 kHz at 800 mV peak-to-peak differential, and baseband bias voltage of +1.15 VDC. In specific bands, the performance is often considerably better, with third-harmonic suppression of –59 dBc from 450 to 960 MHz and –56 dBc from 3400 to 3800 MHz **(Fig. 4)**.

The high dynamic range of the HMC495LP3 is evident in its outstanding adjacent-channel-power-ratio (ACPR) performance under WCDMA conditions **(Fig. 5)**. When driven to –14 dBm of WCDMA channel power at 2140 MHz, the HMC495LP3 provides ACPR performance of better than –59 dBc in both upper and lower adjacent channels. This performance is as good or better

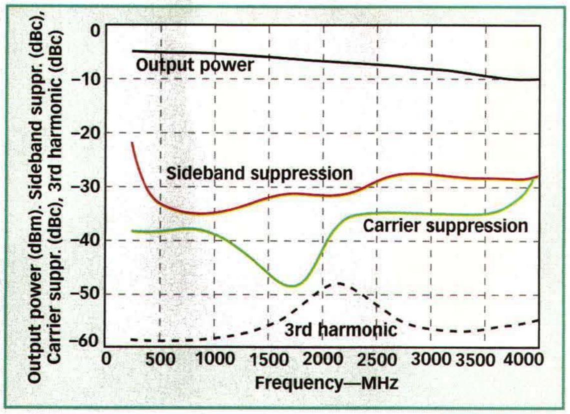


2. The HMC495LP3 direct quadrature modulator includes carefully matched signal paths with a pair of mixers offset by 90 deg.

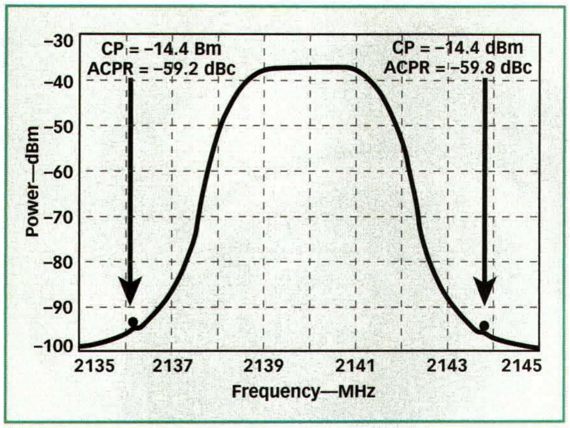


3. This plot shows the output third-order-intercept point, output noise floor, and measurement setup noise floor as functions of frequency for the HMC495LP3.

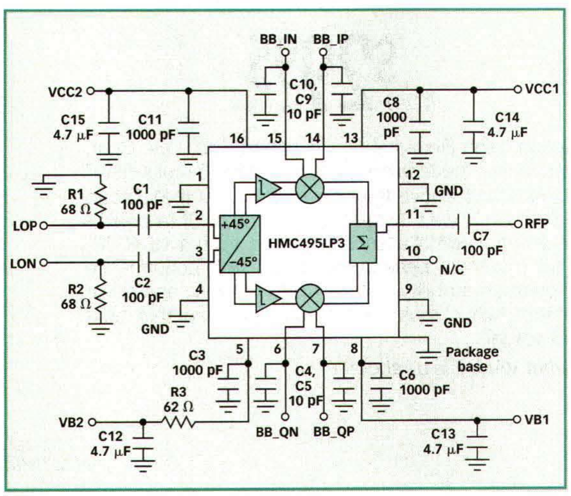
than other, more narrowband direct modulator RF ICs. Note that the WCDMA ACPR was measured at an offset of 3.84 MHz using a spectrum analyzer with 30-kHz resolution-bandwidth filters, V_{cc} of +3.3 VDC, and baseband bias voltage of +1.15 VDC.



4. The HMC495LP3's output power, sideband suppression, carrier suppression, and third-harmonic distortion are shown here as functions of frequency.



5. The ACPR performance of the HMC495LP3 is plotted here under WCDMA signal conditions at 2140 MHz.

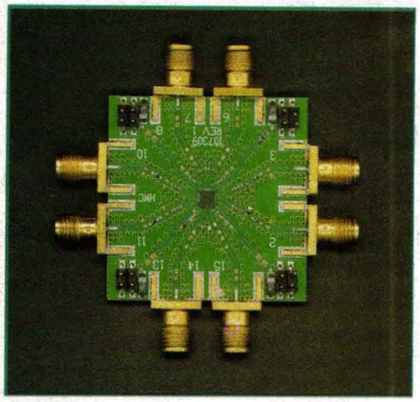


6. This schematic diagram shows a typical printed-circuit-board (PCB) application for the HMC495LP3 direct quadrature modulator.

The versatile HMC495LP3 direct quadrature modulator accepts a wide range of LO input power levels from –6 to +6 dBm, and delivers an extremely wide I and Q modulation bandwidth of DC to 250 MHz (in support of virtually all existing and many emerging modulation formats) when using the recommended 10-pF shunt capacitors. The HMC495LP3 will provide stable operation over a supply voltage range of +3.0 to +3.6 VDC, and a temperature range of –40 to +85°C.

The LO port of the HMC495LP3 can be driven in either single-ended or differential mode. Driving the LO port in single-ended mode will eliminate the need for an external balun, the cost of which will depend on the frequency and bandwidth of operation. Driving the LO port in differential mode will improve the carrier suppression level by about 3 dB at 3500 MHz, although the relative improvement will be less at lower frequencies. Modulator carrier suppression can be improved by adjusting the DC offset in the I and Q input ports. The ideal DC offset of the I and Q signals depends on the final circuit layout, so the DC offset should be adjusted accordingly to correct for any slight asymmetries in the final circuit layout.

Similarly, the HMC495LP's sideband suppression can be optimized by adjusting the gain



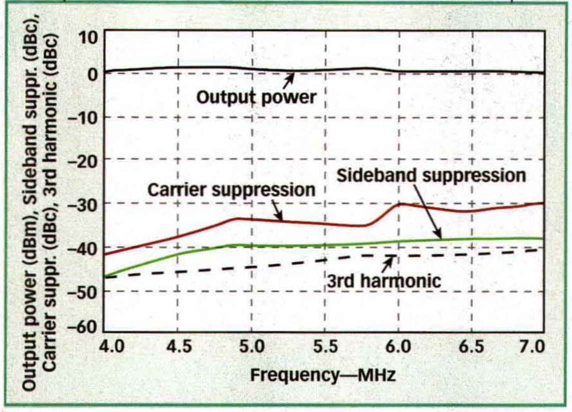
7. This photograph shows a packaged HMC495LP3 mounted on one of the company's evaluation boards.

and phase offset between the I and Q input ports. As with the carrier-suppression DC offset adjustment, the ideal gain and phase offset between the I and Q signals depends on the actual application circuit.

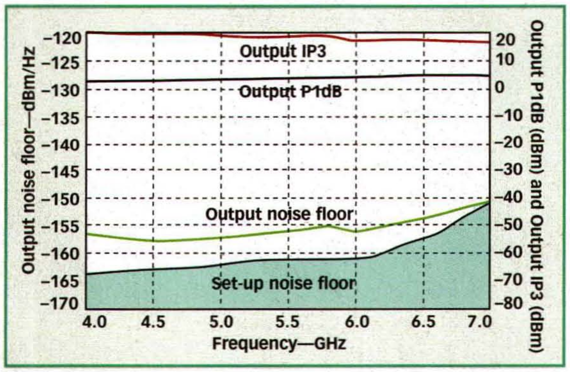
The HMC495LP3 can be used to create virtually any analog- or digital-modulation format including binary phase-shift keying (BPSK), quadrature phase-shift keying (QPSK), eight-state phase-shift keying (8PSK), orthogonal frequency-division multiplex (OFDM), and quadrature amplitude modulation (QAM). The direct quadrature modulator's wide bandwidth and low noise floor make it a suitable choice for base-station, access point, and customer-premises-equipment (CPE) applications in the cellular, personal-communications-services (PCS), UMTS, fixed wireless, and HiperLAN/HiperMAN WLAN bands. This wideband capability allows the transceiver designer to use a common printed-circuit-board (PCB) design for multiple frequency bands. The HMC495LP3 is also well suited for applications in software-defined radios (SDRs) where the upconverter must dynamically vary its modulation format depending on changing conditions and requirements **(Fig. 6)**.

For the measurements shown in this article, data were taken with a single-ended LO source applied to the HMC495LP's LOP port, with the LON port terminated to ground through a 50-Ω resistor **(Fig. 7)**. A shunt 68-Ω resistor is used on each of the LON and LOP ports to improve LO port return loss, while a 100-pF series capacitor prevents DC voltage from appearing on the application PCB.

The HMC495LP3 has two supply and two bias input lines. To reduce any power-supply noise, each of these lines is decoupled by shunt 4.7-µF capacitors placed close to the input connector, and shunt 1000-pF capacitors placed in close proximity to the 3 × 3-mm package. The nominal supply voltage for V_{cc1} and V_{cc2} is +3.3 VDC. Voltage V_{bb1} is tied to V_{cc}, while the V_{bb2} voltage is dropped to +3.0 VDC through a series 62-Ω resistor; this reduction in V_{bb2} will improve the sideband suppression and output noise, while reducing the overall power consumption. The RF output of the HMC495LP3 is single ended and a series 100-pF capacitor is used for DC blocking.



8. These curves show the HMC496LP3's output power, sideband suppression, carrier suppression, and third-harmonic distortions as functions of frequency.



9. These curves show the HMC496LP3's output third-order intercept point, output power at 1-dB compression, output noise floor, and measurement setup noise as functions of frequency.

The IP/IN and QP/QN ports of the HMC495LP3 are DC coupled to allow modulation frequencies down to DC. All four ports are shunted to ground with a 10-pF capacitor. This capacitance value was chosen for a low impedance to ground at the LO frequency, in order to improve the carrier suppression and to filter noise. The HMC495LP's modulation bandwidth can be increased beyond 250 MHz by removing these capacitors or reducing their values.

In addition to the HMC495LP3, the company has also announced the HMC496LP3 4.0-to-7.0-GHz SiGe direct modulator for higher-frequency applications. It offers typically –39 dBc sideband suppression and –35 dBc carrier suppression, with third-harmonic intermodulation levels of typically –44 dBc **(Fig. 8)**. These suppression levels were measured with typical output power of +3 dBm, V_{cc} of +3.0 VDC, baseband frequency of 200 kHz at 1.2 V peak-to-peak differential voltage and V_{dc} of +1.3 VDC.

The HMC496LP3 achieves output power at 1-dB compression of typically +3 dBm at 4.0 GHz and +4 dBm at 6.0 GHz. The output noise floor is typically –157 dBm in a 1-Hz bandwidth from 4.0 to 6.0 GHz **(Fig. 9)**, when measured at an offset of 20 MHz, with V_{cc} of +3.0 VDC and V_{dc} of +1.3 VDC. These values translate into a dynamic range of approximately 160 dB from 4.0 to 6.0 GHz.

Both the HMC495LP3 and the HMC496LP3 wideband SiGe direct quadrature modulators are available from stock. Complete specifications can be found on the company's website. The company also offers evaluation boards fabricated on high-performance 4350 PCB material from Rogers Corp. (Rogers, CT) with SMA connectors for ease of testing. **Hittite Microwave Corp., 12 Elizabeth Dr., Chelmsford, MA 01824; (978) 250-3343, FAX: (978) 250-3373, Internet: www.hittite.com.**

PRODUCT technology

Carrier-To-Noise Generators Enhance BER Testing

These communications test instruments offer increased accuracy through the careful control of potential causes of measurement uncertainty.

MICHAEL CAGNEY
Vice President of Sales and Marketing
dBm Corp., 6 Highpoint Dr., Wayne, NJ 07470; (973) 709-0020, FAX: (973) 709-1346, e-mail: info@dbmcorp.com, Internet: dbmcorp.com.

Carrier-to-noise (C/N) generators continue to be essential ingredients in evaluating the performance of receivers employed in CATV, cellular, satellite communications, and WLAN systems. These instruments essentially combine a carrier supplied by the user with internally generated additive white Gaussian noise (AWGN) source to produce an output signal that contains a precise ratio of carrier and noise.

They are particularly well suited for BER, SINAD, and channel-impairment testing, in which they can help determine a receiver's ability to perform under a wide range of signal conditions. C/N generator architecture has changed little over the years, while the expected performance of communications systems has dramatically increased. To address the need for greater instrument capability, accuracy, and reliability, dBm Corp. (Wayne, NJ) has created the CNG Series C/N generators using an architecture that delivers significant improvements in performance, ease of use, and long-term reliability.

The CNG Series **(see figure)** is a family of instruments with models targeted at intermediate-frequency (IF) applications (typically 70 and 140 MHz) and RF applications from 800 MHz to 6.0 GHz (with specialized models covering frequencies to 30 GHz). The frequency bands of the standard models correspond to the interference conditions required by applications such as satellite or cellular/PCS communications, WLAN, and CATV, and the instruments are compatible with all analog and digital modulation schemes. Fully automated operating modes include C/N, C/N_o, E_bN_o, and C/I modes. The instruments feature noise bandwidths from 50 to 180 MHz.

The CNG Series of carrier-to-noise generators provide one or two channels of precisely calibrated ratios of carrier signals and AWGN for IF and RF testing.

The instruments can be used in bench-top environments or as part of an automatic-test-equipment (ATE) system for production testing. In the latter application, the use of solid-state attenuators extends the service life and reliability of the instrument and increases execution speed, key considerations in high-volume production testing. The front-panel controls include separate keys to invoke each main function with LED indicators and a bright LCD display to provide a clear indication of all settings.

The CNG Series instruments are available with one or two independent RF channels, for simplex, diversity, or duplex testing. As many as 10 test scenarios can be stored in memory, and the instrument will automatically measure the carrier signal and precisely adjust the power of the internal noise source to maintain the desired ratio. External

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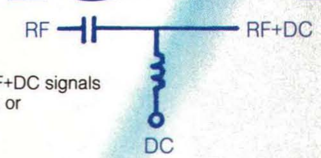

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Now up to 500mA DC current 100kHz-6GHz

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Mini-Circuits...we're redefining what VALUE is all about!

Model	Freq (MHz)	Insertion Loss (dB Typ.)			Isolation (dB Typ.)			VSWR (Typ.)	Price $ ea
	F_L-F_U	L	M	U	L	M	U	U	1-9 qty.
▲ZFBT-4R2G	10-4200	0.15	0.6	0.6	32	40	50	1.13:1	59.95
▲ZFBT-6G	10-6000	0.15	0.6	1.0	32	40	30	1.13:1	79.95
▲ZFBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	50	1.13:1	79.95
▲ZFBT-6GW	0.1-6000	0.15	0.6	1.0	25	40	30	1.13:1	89.95
▲ZFBT-4R2G-FT	10-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	59.95
▲ZFBT-6G-FT	10-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-4R2GW-FT	0.1-4200	0.15	0.6	0.6	N/A	N/A	N/A	1.13:1	79.95
▲ZFBT-6GW-FT	0.1-6000	0.15	0.6	1.0	N/A	N/A	N/A	1.13:1	89.95
★ZNBT-60-1W	2.5-6000	0.2	0.6	1.6	75	45	35	1.35:1	82.95
■PBTC-1G	10-1000	0.15	0.3	0.3	27	33	30	1.10:1	25.95
■PBTC-3G	10-3000	0.15	0.3	1.0	27	30	35	1.60:1	35.95
■PBTC-1GW	0.1-1000	0.15	0.3	0.3	25	33	30	1.10:1	35.95
■PBTC-3GW	0.1-3000	0.15	0.3	1.0	25	30	35	1.60:1	46.95
•JEBT-4R2G	10-4200	0.15	0.6	0.6	32	40	40	-	39.95
•JEBT-6G	10-6000	0.15	0.7	1.3	32	40	40	-	59.95
•JEBT-4R2GW	0.1-4200	0.15	0.6	0.6	25	40	40	-	59.95
•JEBT-6GW	0.1-6000	0.15	0.7	1.3	25	40	30	-	69.95

L = Low Range M = Mid Range U = Upper Range

NOTE: Isolation dB applies to DC to (RF) and DC to (RF+DC) ports.

▲SMA Models, FT Models Have Feedthrough Terminal ★Type N, BNC Female at DC

■Pin Models •Surface Mount Models

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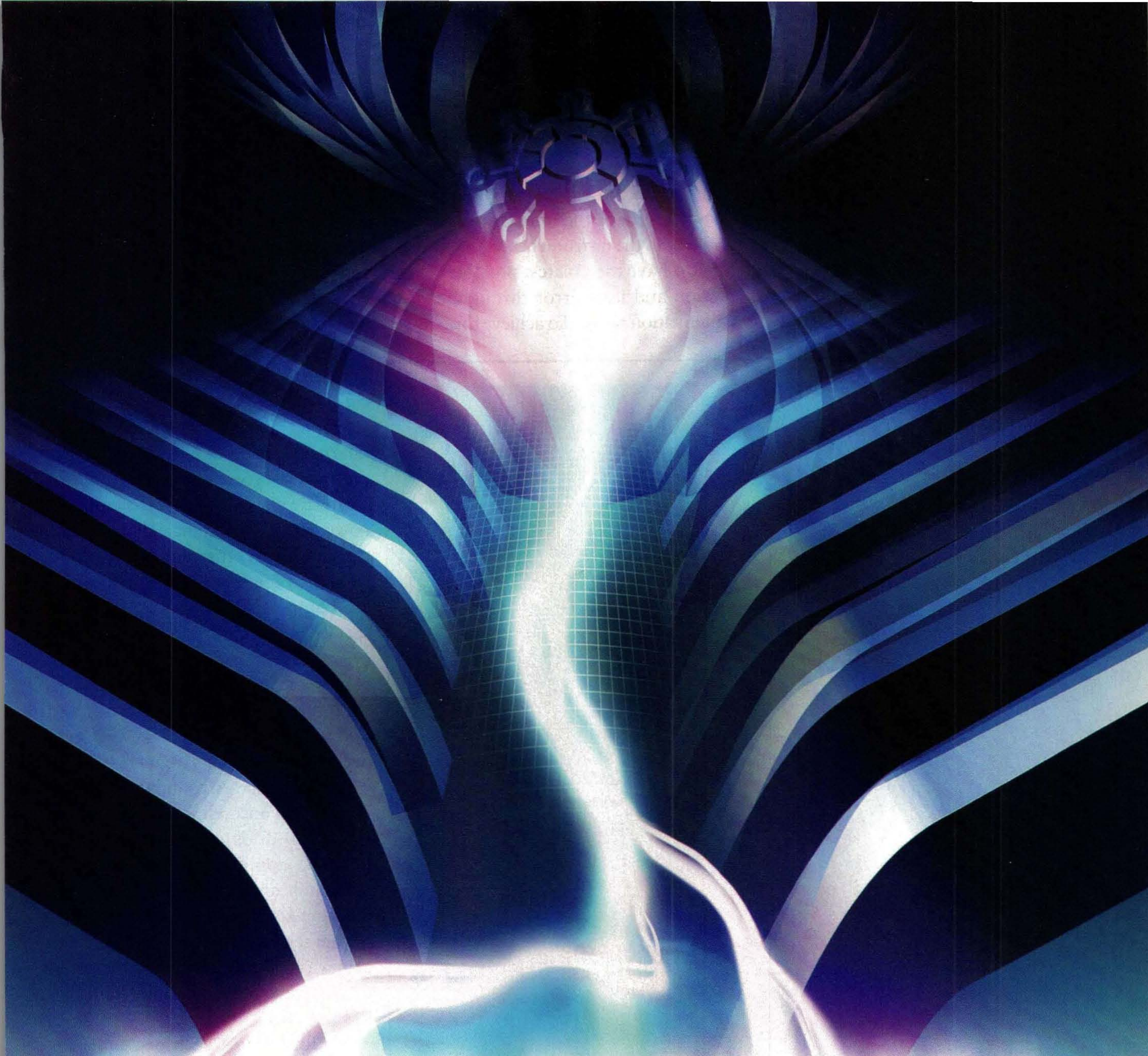
interference signals can also be injected in place of the internal sources, for measurements of carrier power, noise power, and interference power, and set the C/N and C/I ratios.

The CNG Series instruments employ a thermal termination as the noise source, rather than the traditional noise diode, eliminating diode-based amplitude distribution errors and providing a high crest factor with no asymmetry in noise-voltage distribution. Compensation is automatically provided for bit rate, signal bandwidth, duty cycle, and power-level settings, and input-signal variations can be automatically tracked and negated to ensure the desired ratio is maintained. The instruments downconvert carrier signals to 140 MHz, measure the power at that frequency, and then add a precise level of noise. The signal with noise is then upconverted to its original frequency. By performing the power measurement and noise addition at IF, very high accuracy can be achieved.

Ratio accuracy is the most important specification for a C/N generator, since it has a direct and dramatic effect on UUT performance. For example, if a 64QAM system is being tested for BER and the C/N ratio uncertainty is a seemingly insignificant ±0.5 dB, the measured BER could nonetheless be inaccurate by a factor of more than 10,000. Consequently, it is imperative that ratio accuracy be as precise as possible—and verifiable. The CNG Series achieves verifiable ratio accuracy of less than 0.2 dB (and typically 0.1 dB) by compensating for every possible source of error.

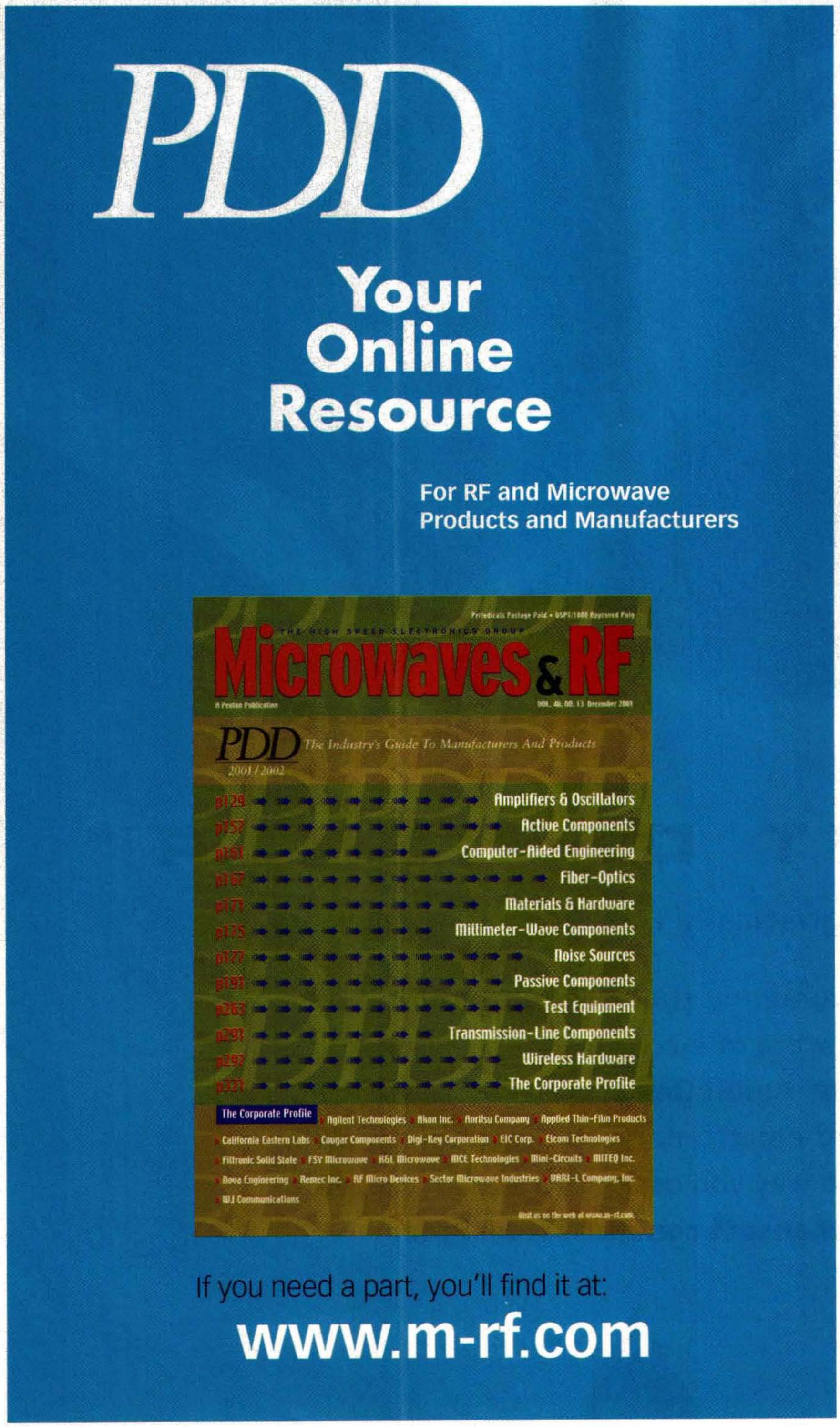
Errors can arise from variations in noise-density and signal-path flatness, step-attenuator resolution, impedance mismatch, and the method and test equipment used for calibration. To minimize all sources of potential error and ensure ratio accuracy, dBm uses various compensation techniques, and overall ratio accuracy is measured in every instrument over the operating frequency and input power range.

In order to maintain a precise level of E_b/N_o over frequency, the instrument must account for signal-path gain variations and noise-density variations over the entire operating frequency of the instrument rather than at a single discrete point. The CNG Series accomplishes this by compensating for noise density and signal gain at all frequencies in 1-MHz increments. For signals that occupy a large bandwidth, there is also a possibility of additional C/N uncertainty caused by variations in the signal-path gain and the noise spectral distribution flatness. The instrument also accounts for these effects, utilizing its internal calibration factors and the



bit-rate parameter value.

The CNG Series employs the substitution method for establishing ratio accuracy, which relies on the accuracy of the noise attenuator and its resolution. The substitution method eliminates errors caused by power-measurement linearity. However, since accuracy is directly determined by the attenuator (perhaps the most critical component in the instrument), it is essential that it have the greatest possible resolution and least error throughout its attenuation range. To achieve this, dBm created its own attenuator design, which has resolution of 0.016 dB, and is compensated in 1-MHz steps at every attenuation setting with a dedicated microprocessor. All attenuators are calibrated and verified over their range of operating frequencies and attenuation. This technique reduces resolution uncertainty to less than 0.008 dB and typical error to less than 0.02 dB.



Similar attention was paid to the internal power meter, which to reduce error must provide compensation for hardware inaccuracy over the full input power range. To eliminate this problem, the CNG Series instruments employ a dedicated microprocessor to provide the compensation, and the user can specify the sampling rate and number of samples. Signal-path gain is also well controlled. Input-to-output gain is typically better than 0 dB ±0.1 dB, and calibration is performed in 1-MHz steps over the instrument's frequency range.

One of the largest contributors to error is mismatch uncertainty. While a return loss of 20 dB is more than adequate for most applications, it results in a mismatch uncertainty of nearly ±0.1 dB. Good matching and careful component selection in the CNG Series help achieve return losses in excess of 26 dB, reducing mismatch uncertainty to less than 0.02 dB.

Calibration of each instrument is fully automated and executed by a single program, and the procedure is performed with software-correction factors resident in the instrument. The instrument is calibrated in 1-MHz increments using a precision reference tunable frequency converter, which ensures that all power measurements are made at 50 MHz, the frequency at which power sensors are typically calibrated, eliminating power-meter uncertainty versus frequency. There are 65 calibration factors collected and stored for each 1 MHz of operating bandwidth, which translates into more than 8500 calibration points for a typical instrument. **dBm Corp., 6 Highpoint Dr., Wayne, NJ 07470; (973) 709-0020, FAX: (973) 709-1346, e-mail: info@dbmcorp.com, Internet: www.dbmcorp.com.** MRF

Circulators/Isolators Serve UMTS Applications

These compact circulators and isolators are designed for high isolation, low insertion loss, and generous power-handling capabilities for UMTS base-station designs.

FREDERIC BEAUJOIN
COLETTE RUINEAU
BEAUDOIN TAMEN
Members of the Technical Staff
Temex, 399, route des Crêtes—06904 Sophia Antipolis Cedex, France; (33)(0)4 97 233 000, FAX: (33)(0)4 97 233 915, e-mail: info@temex.fr, Internet: www.temex.net.

Circulators and isolators are essential components in many communications systems, since they can be used to direct RF/microwave signals between ports as well as provide high isolation. These inherently narrow-band components are designed for specific applications, such as the new line of drop-in and surface-mount circulators and isolators in the NE3101 and NE1101 lines from Temex for use in Universal Mobile Telecommunications System (UMTS) applications from 2080 to 2200 MHz. The components feature low intermodulation distortion (IMD) and generous power-handling capabilities.

The high data rates (2 MB/s) expected of UMTS translates into demanding specifications for communications system components such as circulators and isolators. For example, typical UMTS third-order IMD requirements are on the order of –80 to –90 dBc when measured with two test tones at about 28 W (+44.5 dBm) each.

The new drop-in circulators and isolators from Temex consist of a stripline center conductor sandwiched between two ferrite disks. The disks are placed between ground planes and magnetically biased by permanent magnets. Using electromagnetic (EM) simulation and analysis computer-aided-engineering (CAE) software, the structure is optimized for the best balance of isolation, loss, and IMD performance in the UMTS band from 2080 to 2200 MHz.

The EM simulations are backed by precision measurements using dual test sources to generate a two-tone test signal for IMD evaluations. The performance of each device under test (DUT) is checked with a spectrum analyzer to gauge the amplitude differences between the CW test tone and the IMD tone. The company's test system achieves a spurious-free dynamic range of better than –120 dBc with two test tones of +44.5 dBm (28 W) each and a through-path calibration standard in place of the DUT, and IMD products below –90 dBc have been measured with the system.

The new circulator/isolator lines feature five models operating at frequencies from 2080 to 2200 MHz **(see table)**. These include circulator models NE3101-100 and NE3101-200 for use from 2080 to 2200 MHz, isolator model NE1101-300 for use from 2110 to 2170 MHz, attenuator model NE1101-200 for use from 2080 to 2200 MHz, and load model NE1101-100 for use from 2080 to 2200 MHz. All derive from the basic ferrite circulator architecture, with all but the model NE1101-300 capable of handling as much as 200 W CW forward power and at least 100 W CW reverse power. The other unit, drop-in isolator model

NE1101-300, is designed for low-power applications where the reverse power does not exceed 1 W.

The models NE3101-100 and NE3101-200 circulators offer better than 21 dB isolation and less than 0.3 dB insertion loss from 2080 to 2200 MHz, each with VSWR of 1.20:1. They are rated for 100 W CW power in the forward and reverse directions. The drop-in model NE3101-100 exhibits –70 dBc IMD performance while the surface-mount model NE3101-200 circulator achieves outstanding IMD performance of better than –85 dBc.

The UMTS circulators/isolators at a glance

MODEL	FREQUENCY RANGE (MHz)	ISOLATION (dB)	INSERTION LOSS (dB)	INTERMODULATION DISTORTION (IMD) (dBc)
NE1101-100	2080 to 2200	>21	<0.3	<-85
NE1101-200	2080 to 2200	>21	<0.3	<-85
NE1101-300	2110 to 2170	>23	<0.3	<-70
NE3101-100	2080 to 2200	>21	<0.3	<-70
NE3101-200	2080 to 2200	>21	<0.3	<-85

The NE1101-300 low-power isolator handles 10 W of forward power and 1 W of reverse power, with better than 23 dB isolation and less than 0.3 dB insertion loss from 2110 to 2170 MHz. It has VSWR of 1.15:1 with IMD performance of better than –70 dBc.

The low-IMD model NE1101-100 drop-in isolator is essentially a circulator terminated with a 50-Ω load. It handles 200 W forward power and 100 W reverse power, with at least 21 dB isolation (attenuation) and less than 0.3 dB insertion loss from 2080 to 2200 MHz. It achieves better than –85 dBc IMD performance with VSWR of 1.20:1 in a drop-in package. Similarly, the NE1101-200 is also a drop-in isolator, but with the terminated port connected to a 20- or 30-dB attenuator for reverse power detection. The NE1101-200 drops IMD levels below –85 dBc while handling 200 W forward power and 100 W reverse power. Like the NE1101-100, it achieves better than 21 dB isolation with less than 0.3 dB insertion loss and 1.20:1 VSWR from 2080 to 2200 MHz.

The NE3101-100 circulator and the NE1101-300 isolator are each supplied in a 19.05 × 19.05-mm drop-in package while the NE3101-200 circulator is provided in a circular package with 19.05-mm diameter. The NE1101-100 and NE1101-200 isolators are housed in packages measuring 19.05 × 25.4 mm. **Temex Electronics, Inc., 17235 N. 75th Ave., Suite G-100, Glendale, AZ 85308; (623) 780-1995, FAX: (623) 780-2431, e-mail: sales.usa@temex.fr, Internet: www.temex.net.**

Third-Generation ICs Speed Bluetooth Integration

This series of single-chip solutions slashes the power and development time needed to include Bluetooth functionality into a wide range of portable products.

JACK BROWNE
Publisher/Editor

Bluetooth is finally reaching the million-piece volumes that members of the Bluetooth Special Interest Group (SIG) foresaw more than five years ago. Some of the widespread acceptance is due to the diminishing costs of Bluetooth integrated circuits (ICs), and some is due to the availability of highly integrated solutions. In the case of latest Bluetooth ICs from Cambridge Silicon Radio (Cambridge, England), both factors apply. The company's BlueCore3 family of products represents a third-generation (3G) development, fully compliant with the latest version of the Bluetooth standard (Version 1.2) and designed for low-power operation at +1.8 VDC.

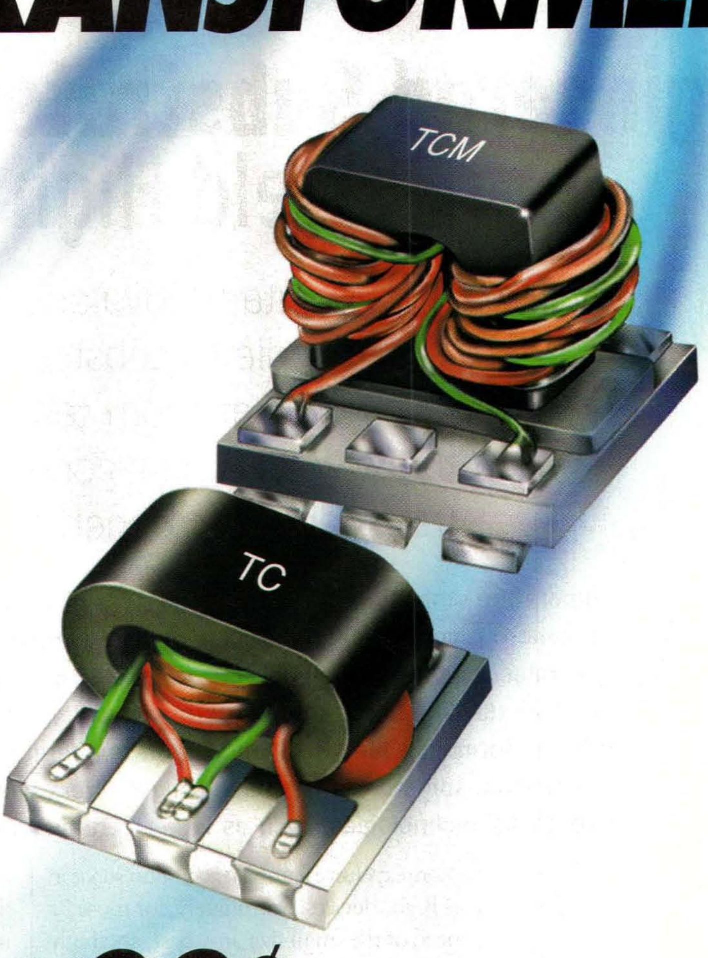
The BlueCore3 family represents the first complete implementation of the 2.4-GHz Bluetooth Version 1.2 standard. The new ICs include the BlueCore3-Multimedia chip and the BlueCore3-ROM chip. The former includes user-programmable digital-signal-processing (DSP) circuitry while the latter is designed to be a lower-power replacement for the company's second-generation (2G) BlueCore2-ROM chip (using 18 percent less power than its predecessor).

Both Bluetooth radio ICs are designed to provide as much as +6-dBm transmitter power with an on-chip 6-b digital-to-analog converter (DAC) for 30-dB dynamic power control. The on-chip receiver (which operates in a near-zero-IF mode) features integrated channel filters digital demodulator, and digitized received-signal-strength-indication (RSSI) function for real-time control.

Both Bluetooth ICs feature advanced baseband and logic circuitry that includes a memory management unit (MMU), burst-mode controller (BMC), 32 kB of random-access memory (RAM), 4 Mb of read-only memory (ROM), Universal Serial Bus (USB) and synchronous serial-port interfaces, universal asynchronous receiver transmitter (UART) interface, audio pulse-code-modulation (PCM) interface, and on-chip RISC microcontroller. Both ICs have an on-chip linear regulator that produces +1.8 VDC when supplied with +2.2- to +4.2-VDC inputs.

The BlueCore3-Multimedia chip is available in a 10 × 10-mm, 96-ball LFBGA package. The BlueCore3-ROM solution can be supplied in a 4 × 4-mm chip-scale package (CSP) as well as in RF Plug & Go and ball-grid-array (BGA) packages. The RF Plug & Go package integrates impedance-matching circuitry for connection to an antenna. **Cambridge Silicon Radio, Cambridge Science Park, Milton Rd., Cambridge CB4 0WH, England; (44) (0) 1223-692-000, FAX: (44) (0) 1223-692-001, e-mail: sales@csr.com, Internet: www.csr.com.**

RF TRANSFORMERS



.3-2500MHz as low as 99¢ each (qty. 100)

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It used to be that small RF transformers with high end performance cost a lot, but not since Mini-Circuits introduced the all ceramic leadless TC and high strength plastic leaded TCM families. Now you can get impedance ratios from 0.1:1 to 16:1 ohms with good return loss and broad bandwidths from 0.3 to 2500MHz at price buster values. Plus, these ultra-small performers are all-welded and have solder plated leads for high reliability and solderability, excellently suited for your automated pick-and-place assembly operations. So have it both ways; high performance AND low price with Mini-Circuits TC and TCM surface mount transformers.

Detailed Performance Data & Specs Online at: **www.minicircuits.com/model**

LEADLESS Ceramic Base (actual size)

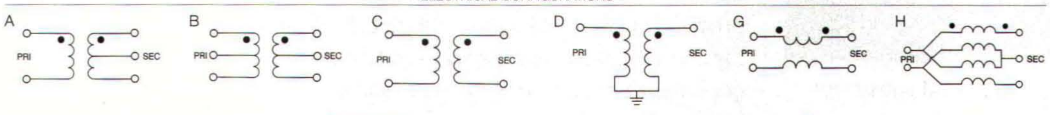
MODEL	Ω Ratio & Config.	Freq. (MHz)	Ins. Loss❖ 1dB (MHz)	Price $ea. (qty. 100)
TC1-1T	1A	0.4-500	1-100	1.19
TC1-1	1C	1.5-500	5-350	1.19
TC1-15	1C	800-1500	800-1500	1.29
TC1.5-1	1.5D	.5-2200	2-1100	1.59
TC2-1T	2A	3-300	3-300	1.29
TC3-1T	3A	5-300	5-300	1.29
TC4-1T	4A	.5-300	1.5-100	1.19
TC4-1W	4A	3-800	10-100	1.19
TC4-14	4A	200-1400	800-1100	1.29
TC8-1	8A	2-500	10-100	1.19
TC9-1	9A	2-200	5-40	1.29
TC16-1T	16A	20-300	50-150	1.59
TC4-11	50/12.5D	2-1100	5-700	1.59
TC9-1-75	75/8D	0.3-475	0.9-370	1.59

LEADS Plastic Base (actual size)

MODEL	Ω Ratio & Config.	Freq. (MHz)	Ins. Loss❖ 1dB (MHz)	Price $ea. (qty. 100)
TCM1-1	1C	1.5-500	5-350	.99
TCML1-11	1G	600-1100	700-1000	1.09
TCML1-19	1G	800-1900	900-1400	1.09
TCM2-1T	2A	3-300	3-300	1.09
TCM3-1T	3A	2-500	5-300	1.09
TTCM4-4	4B	0.5-400	5-100	1.29
TCM4-1W	4A	3-800	10-100	.99
TCM4-6T	4A	1.5-600	3-350	1.19
TCM4-14	4A	200-1400	800-1000	1.09
TCM4-19	4H	10-1900	30-700	1.09
TCM4-25	4H	500-2500	750-1200	1.09
TCM8-1	8A	2-500	10-100	.99
TCM9-1	9A	2-280	5-100	1.19

Dimensions (LxW): TC .15" x .15" TCM .15" x .16" ❖Referenced to midband loss.

ELECTRICAL CONFIGURATIONS



Engineered Substrates Yield High Stability

A proprietary covalent bonding process attaches die to substrates and substrates to carriers at room temperature, clearing the way for a new generation of temperature-stable components.

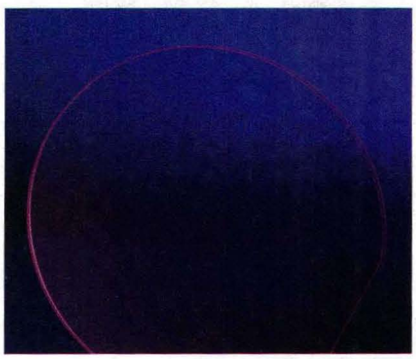
JACK BROWNE
Publisher/Editor

Temperature stability is a key to the successful integration of numerous components, including filters and resonators, in wireless and other designs. For example, surface-acoustic-wave (SAW) devices offer superb selectivity, although with performance highly dependent on temperature. For this reason, some designers have sought filters based on alternative technologies, such as larger ceramic filters or more expensive film-bulk acoustic resonator (FBAR) devices. Fortunately, for those in need of the small size, low cost, and high performance of SAW filters (and resonators), Ziptronix (Research Triangle Park, NC) provides a solution in the form of engineered substrates: the company's unique, covalent bonding process yields piezoelectric and other substrates that can be bonded to carriers such as glass for enhanced temperature stability.

Founded in 2000, the company uses its proprietary ZiROC™ covalent bonding technology at room temperature to perform wafer-to-wafer bonding and die-to-wafer bonding on 4-to-8-in. wafers. The covalent bonding process includes precise polishing of the materials to be bonded to form two materials into one with high bond energy between the two material components. The non-adhesive process is performed at room temperature, without the high processing temperatures that can be destructive to some sensitive semiconductor die and surface-mount components.

Compared to fusion-bonding or anodic-wafer-bonding processes, the ZiROC process is performed at room temperature to create low-stress bonds and materials with minimum defects and low thermal resistance. The process can bond materials with different coefficients of thermal expansion (CTE), supports standard through-bond processing, and enables multilayer circuitry using a three-dimensional interconnect topology.

The company has applied its revolutionary process to create a "standard" line of substrates aimed at developers of SAW filters and oscillators **(see figure).** Each of these temperature-compensated SAW substrates is actually a wafer pair consisting of a low-cost piezoelectric material, such as lithium tantalite and lithium niobate, bonded to glass, quartz, or other base wafer with low CTE. The resulting engineered wafer exhibits the electrical properties of the piezoelectric top wafer layer with the thermal stability of the base substrate. These new materials will enable designers to create temperature-stable piezoelectric-based components for a variety of functions in communications systems, including resonators, oscillators, and filters. **Ziptronix, Inc., Research Triangle Park, NC; Internet: www.ziptronix.com.**

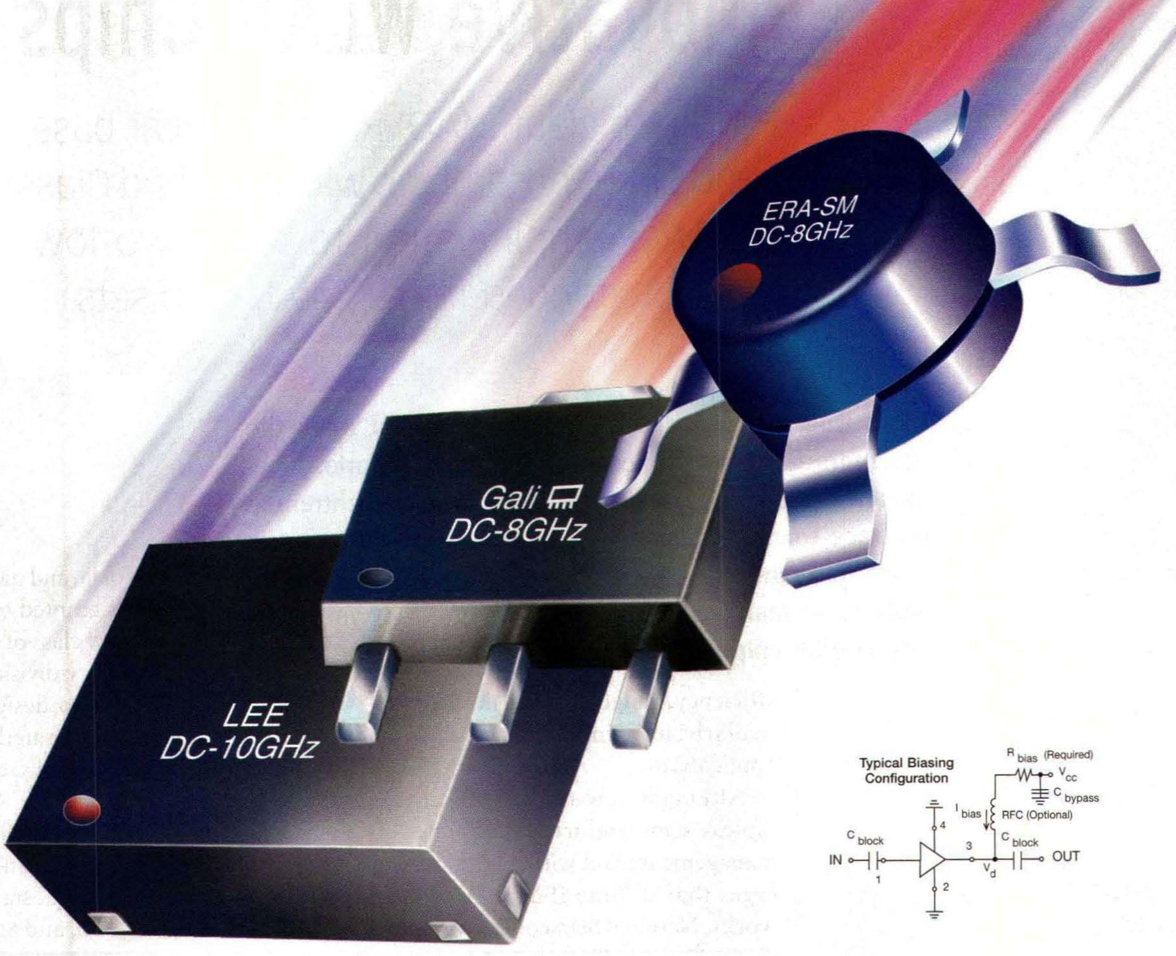


The first line of engineered substrates from Ziptronix includes glass- or quartz-bonded piezoelectric wafers for low-cost, temperature-stable SAW devices.

IN STOCK

MMIC AMPLIFIERS

DC-10GHz as low as 99¢ ea. (qty. 30)



GAIN FROM 8 up to 23dB, OUTPUT POWER up to +20dBm

If you need to find a MMIC amplifier with just the right performance and size to fit your design, your job just got easier! Introducing Mini-Circuits LEE, Gali, and ERA-SM families. Now you can select from a variety of over 40 broadband InGaP HBT and low noise silicon based models with flat gain from 8 up to 23dB, low to high output power of +2.8 to +20dBm, and very high IP3 up to 36dBm typical. These affordable, rugged, compact amplifiers have low thermal resistance for high reliability, and come in three different

package styles to suit your design layout requirements; *the leadless 3x3mm "Mini-Circuits Low Profile" (MCLP™) package with exposed metal bottom for superior grounding and heat dissipation,* plus the SOT-89 and Plastic Micro-X with leads for easier assembly. You'll find all the performance specs and data on our web site, plus a wide selection of amplifier Designer's Kits with free test fixture included! So broaden your MMIC amplifier choices and maximize performance with Mini-Circuits LEE, Gali, and ERA-SM.

Detailed Performance Data & Specs Online at: ***www.minicircuits.com/amplifier.html***

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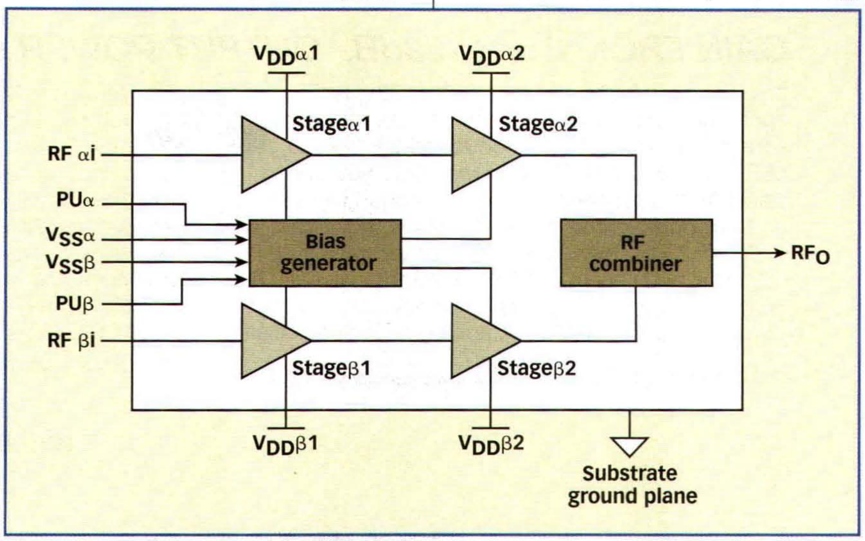
New Supplier Debuts Innovative WLAN Chips

Power-efficient MAC, RF, and digital baseband circuitry combine with switched Class F power amplification to form two low-power, extended-range WLAN chip sets.

JACK BROWNE
Publisher/Editor

If it is true that one day the last shall be first, then the designers at IceFyre Semiconductor (Kanata, Ontario, Canada) have an edge. The company, a relatively late entrant in the race for wireless-local-area-network (WLAN) market share, has joined the competition in a big way, sampling its high-performance SureFyre™ 802.11a and TwinFyre™ 802.11a/b/g chip sets with promises of improved power efficiency, range, and sensitivity, particularly for demanding multimedia applications.

Although new to the market, the fabless semiconductor firm boasts a management team with impressive lineages that include IBM, Nortel Networks, National Semiconductor, Intersil, and Nokia, and more than 31 patents granted or pending for a new class of orthogonal-frequency-division-multiplexing (OFDM) radio design. The company's first two integrated-circuit (IC) sets are the SureFyre family, designed to support the 5-GHz IEEE 802.11a standard for bit rates to 54 Mb/s, and the TwinFyre family, which can be used for the three leading WLAN standards, IEEE 802.11a, 802.11b, and 802.11g,



The ICE5352 OFDM power amplifier employs two active GaAs PHEMT stages and a patented Chireix combiner to reach new levels of efficiency at 5 GHz.

at both 2.4 and 5 GHz.

The SureFyre system is comprised of three chips: the ICE5351 802.11a combination baseband processor and RF radio IC, the ICE5125 802.11 general-purpose media-access-controller (MAC) IC, and the ICE5352 power-amplifier (PA) IC. The SureFyre chip set supports WLAN designs from 4.90 to 5.85 GHz using OFDM modulation, and can achieve high transmit power levels (and improved range) with reduced power consumption compared to competing 802.11b solutions. The first two chips are fabricated with an 0.18-μm RFCMOS silicon process while the PA is fabricated with GaAs. The chips combine to achieve more than 200 mW transmitter average RMS output power and receiver sensitivity that exceeds the 802.11a standard by as much as 10 dB. The system error-vector-magnitude (EVM) performance is 2 dB better than the 802.11a requirement, and the system-level noise figure is less than 8 dB. System power consumption is extremely low at 1015 mW for 100 mW EIPR. Of note for multimedia system designers, the delay spread for the SureFyre system is an almost-negligible 150 ns.

The chip set's individual components include the ICE5351, which combines low-power differential RF circuitry and the digital baseband

The SureFyre chip set can achieve high transmit power levels (and improved range) with reduced power consumption compared to competing solutions.

architecture on the same device. The integrated partitioning is well suited for support of proprietary MACs and embedded host-based MAC platforms, in contrast to the limitations of chips that integrate a baseband processor with the MAC. The ICE5351 can handle data rates of 6, 9, 12, 18, 24, 36, 48, and 54 Mb/s. It employs unique algorithms to limit the peak-to-average power ratio (PAPR) of OFDM signals (maintaining a constant amplitude envelope) for maximum efficiency when used with the ICE5352 PA. Its receiver architecture does not require an external intermediate-frequency (IF) filter or baseband filter components, yet achieves receive sensitivity is –89 dBm at 6 Mb/s and –70 dBm at 54 Mb/s. The ICE5351 includes an automatic-gain-control (AGC) circuit with 0-to-70-dB range, and a transmit-power-control range of better than 20 dB. The nique

AGC circuitry is capable of settling in a few short symbols, giving the receiver unprecedented response time and enhanced efficiency. The IC shaves peak transmit power consumption to less than 570 mW and achieves transmit EVM of –27 dB at all data rates and output power levels. The ICE5351 is supplied in a 15 × 15 × 1.6-mm low-profile fine-pitch ball-grid-array (LFBGA) housing.

The ICE5125 802.11 MAC is compliant with 802.11a, b, and g standards. The IC includes a 32-b bus master DMA controller to transfer data to and from the system memory, minimizing the load on the host central-processing unit (CPU). The MAC supports a variety of security methods as well as 64- and 128-b encryption keys.

The ICE5352 GaAs PHEMT amplifier is unique among WLAN PAs, employing efficient Class F switch-mode technology along with Chireix combiners.

For 802.11a/g, it support data rates of 6, 9, 12, 18, 24, 36, 48, and 54 Mb/s, while for 802.11b, it supports data rates of 1.0,2.5, 5.0, and 11.0 Mb/s. It supports automatic rate switching to adapt to different link conditions. It features on-chip packet buffers, supports dynamic frequency selection and transmit-power-control functions, and includes Windows 2000, Windows XP, and Linux 2.4 drivers. The ICE5125 is supplied in a 12 × 12 × 1.4-mm LFBGA housing.

The cornerstone of the SureFyre collection, the ICE5352 gallium-arsenide (GaAs) pseudomorphic-high-electron-mobility-transistor (PHEMT) amplifier is optimized for use from 5.15 to 5.35 GHz and is first in a family of PAs covering the global 4.9-to-5.85-GHz band. It is unique among WLAN PAs, employing efficient Class F switch-mode technology along with patented low-loss Chireix signal combiners **(see figure)**. The result of this novel technology is an amplifier capable of delivering 125 mW (+21 dBm) output power with 35-percent power-added-efficiency (PAE) for IEEE 802.11a applications, or 200 mW (+23 dBm) output power with 31-percent PAE. The amplifier can provide continuously variable output-power levels from +2 to +23 dBm (by varying the DC supply voltage from +0.5 to +7.0 VDC), and achieves system-level transmit modulation accuracy (EVM performance) of –27 dB at a

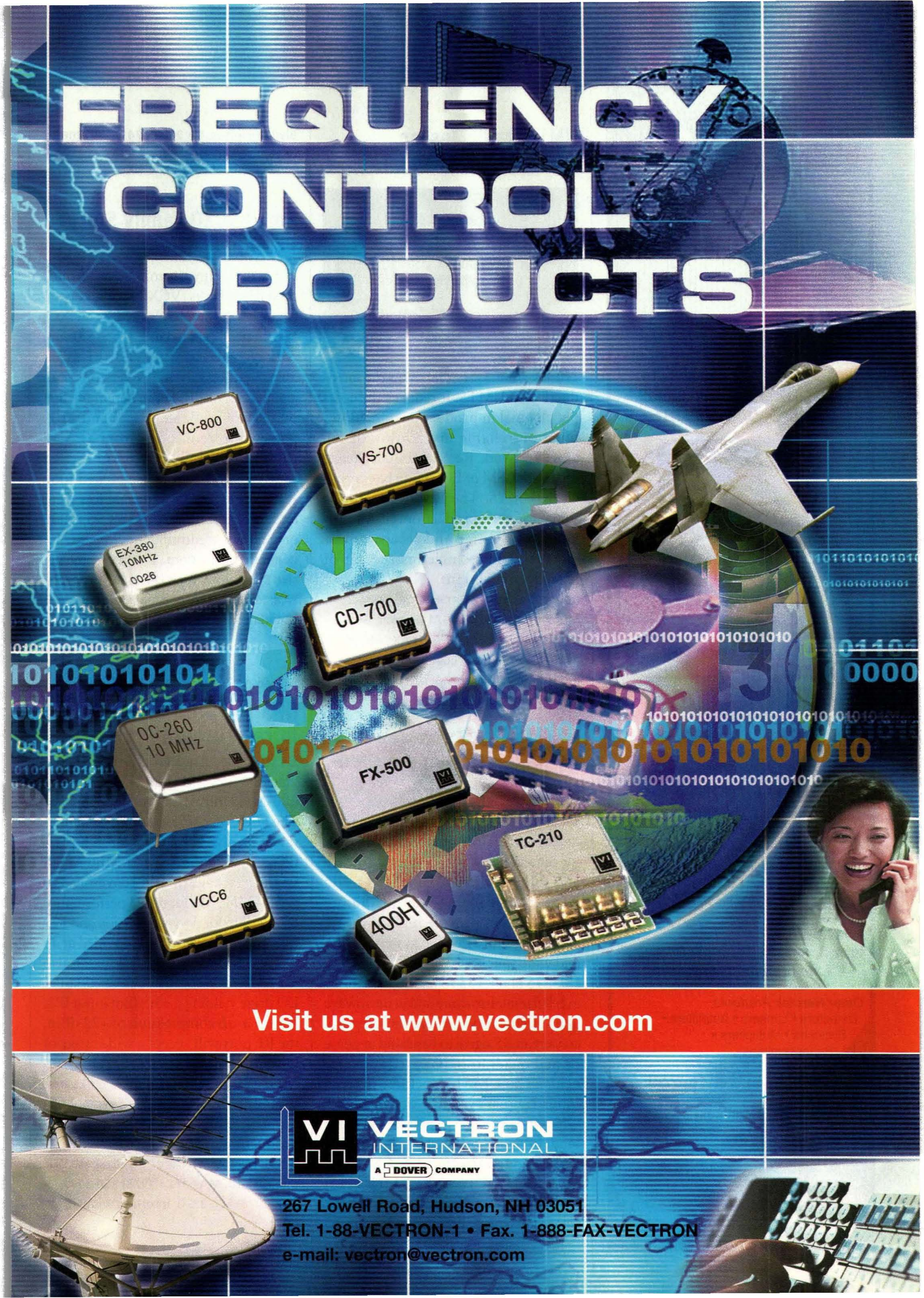
data rate of 54 Mb/s. The amplifier consumes only 360 mW power when generating +21 dBm output power and only 250 mW power when generating +19 dBm output power. The ICE5352 PA is supplied in an 8 × 8-mm, 15-pin ceramic-leadless-chip-carrier (CLCC) package.

For developers working on multiple-WLAN-standard solutions, the TwinFyre™ 802.11a/b/g system handles the three leading WLAN standards at both 2.4 and 5 GHz. The chip set consists of the ICE2501 802.11b/g RF IC, the ICE5825 802.11a IC with baseband processor, the ICE5125 802.11 MAC, and the ICE5352 PA. The system is ideal for partner-provided commodity 2.4-GHz radios and third-party MAC solutions, with strong support for IEEE 802.11b and IEEE 802.11g.

The TwinFyre chip set basically adds 802.1b and 802.11g capabilities to the 802.11a performance of the SureFyre system, with as much as +17 and +22 dBm output power while working in 802.11b and 802.11g operation modes, respectively. The TwinFyre system offers 10 dB better receive sensitivity than the 802.11b/g specifications.

Both the SureFyre and TwinFyre chip sets benefit from innovative technology, including TrueSygnal™ per packet equalization and decode processing, which provides equalization of all carriers in the presence of fading and dynamic-channel-quality assessment to select optimal channels in the presence of interference while optimizing output power levels. Working with a Viterbi decoder, the TrueSygnal approach uses equalization results (channel state information) to optimize the decoding process based on the quality of the receive carrier signals. The IcePick™ per packet antenna diversity provides as much as 10 dB additional gain in receiver sensitivity, especially in multipath environments. Another feature offered is Transmit per Packet Power Control (TPPC), which provides for dynamic interference avoidance, whereby the transmitted power of each OFDM packet is adjusted for optimal AP-STA performance, but minimal RF network interference.

The ICE5351 and ICE5352 ICs are currently available in sample quantities as part of the ICE5300A-EVK evaluation kit, while the ICE5125 is sampling as part of the ICE5100A-EVK evaluation kit. SureFyre-based Mini-PCI reference designs will be available during the last quarter of 2003. The TwinFyre chip set will begin sampling in the second quarter of 2004, with volume production expected by the third quarter of 3004. **IceFyre Semiconductor Corp., 300-411 Legget Dr., Kanata, Ontario K2K 3C9, Canada; (613) 599-3000, FAX: (613) 599-4965, Internet: www.IceFyre.com.**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13dB	DBTC-13-4	5-1000	0.7	18
13dB	DBTC-13-5-75	5-1000	1.0	19
		1000-1500	1.4	17
16dB	DBTC-16-5-75	5-1000	1.0	21
		1000-1500	1.3	19
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		1000-1500	1.0	20
		1500-2000	1.1	14
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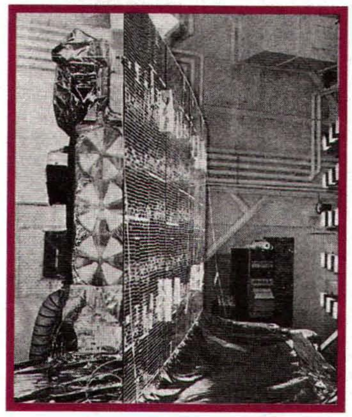

ALMOST 20 YEARS AGO, RCA Astro Electronics (Princeton, NJ) received a $171 million contract from the Space Division of the US Air Force for four weather satellites for the Defense Meteorological Satellite Program.

next month

Microwaves & RF November Editorial Preview

Issue Theme: Microwaves & Optics

News

Optical-communications markets appeared to explode near the end of the last century. Unfortunately, the cost of building high-speed optical networks and links far exceeded the expected incomes, leaving many suppliers of optical components holding large inventories by the end of 2000. What is the state of high-speed optical communications today, and is there still a need for OC-768 (40-Gb/s) systems? A special report in November will shed some light on high-speed fiber optics.

Design Features

November will examine simple photonic-bandgap (PBG) structures and how they can be used to provide effective and flexible control of electromagnetic (EM) waves in specific directions. In other articles, authors from New Jersey will detail linearization techniques for high-power microwave power modules (MPMs) capable of delivering 50 to 250 W, a well-known modulation expert offers an update on minimum-sideband (MSB) ultra-narrowband modulation techniques for high-data-rate communications, and a physicist will share his thoughts on characterizing reed relays for applications through 10 GHz.

Product Technology

November unveils the latest version of a powerful frequency-domain circuit design environment based on a unique time-synchronous data-flow simulator. The software allows analog and digital designers to view their projects by means of frequency-domain parameters (rather than the time domain of traditional SPICE). Additional product Features will explore a family of highpass filters with cutoff frequencies from 600 to 3000 MHz fabricated on low-temperature-cofired-ceramic (LTCC) materials, a group of high-performance frequency synthesizers from a source previously associated with receiver systems, and a line of frequency-tunable substrate materials.